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Sonargaon University (SU)
সোনারগাঁও ইউনিভার্সিটি (এসইউ)

147/I, Green Road, Panthapath, Dhaka

A Theses
on
Air Conditioning System

Submitted by

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LETTER OF TRANSMITTAL

23 May 2023

To,

Tanvirul Abedien

Lecturer

Department of Mechanical Engineering.

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Subject: **Submission of Project Report.**

Dear Sir,

We are pleased to submit the project report on "Air Conditioning System". It was a great pleasure to work on such an important topic. This project has been done per the instruction of your supervision and according to the requirements of Sonargaon University.

We expect that the concerned authority will accept the project. We are happy to explain anything further as you may feel necessary.

Sincerely yours,

Md. Shamsul Islam	ID: BME 1303001041
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STUDENT'S DECLARATION

We do hereby solemnly declare that, the work presented here in this project report has been carried out by us and has not been previously submitted to any University/ Organization for the award of any degree or certificate.

We hereby ensure that the works that have been prevented here do not breach any existing copyright.

We further undertake to indemnify the university against any loss or damage arising from a breach of the foregoing obligation.

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project. In my opinion, this project is satisfactory in terms of scope and quality for the award of the degree of Bachelor of Science in Mechanical Engineering.

Tanvirul Abedien

Lecturer,

Department of Mechanical Engineering

Sonargaon University (SU)

ACKNOWLEDGEMENT

First,

We started in the name of Almighty Allah. This thesis is accomplished under the supervision of

Tanvirul Abedien,

Lecturer

Department of Mechanical Engineering,

Sonargaon University.

It is a great pleasure to acknowledge our profound gratitude and respect to our supervisor for this consistent guidance, encouragement, helpful suggestion, constructive criticism, and endless patience through the progress of this work. The successful completion of this thesis would not have been possible without his persistent motivation and continuous guidance.

The authors are also grateful to Professor Md. Mostofa Hossain, Head of the Department of Mechanical Engineering, and all respectful teachers of the Mechanical Engineering Department for their cooperation and significant help in completing this project work successfully.

ABSTRACT

This book presents a collection of university theses focused on the advancements in small air conditioning systems. As environmental concerns grow and energy efficiency becomes a paramount consideration, the development of compact and efficient air conditioning solutions has gained significant importance.

The compilation showcases diverse research conducted by scholars from various universities, covering a wide range of topics related to small air conditioning systems. The theses delve into multiple aspects, including design principles, novel technologies, energy optimization strategies, environmental impact assessments, and user comfort evaluations.

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Keyword:

1. Split Type air-Conditioner,
2. Out Door Unit,
3. Indoor Unit, Compressor,
4. Condenser,
5. Evaporator,
6. Capillary Tube,
7. Expansion Valve Etc.

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CHAPTER 1

Introduction

The introduction of split case small air conditioners has revolutionized the way cooling systems are designed and installed in residential and small commercial settings. These compact and versatile AC units have gained popularity due to their flexibility, efficiency, and ease of installation. Unlike traditional central air conditioning systems that rely on extensive ductwork, split case small AC units consist of two main components: an outdoor condenser unit and an indoor evaporator unit. These components are connected by refrigerant lines and electrical wiring, eliminating the need for ducts and offering greater flexibility in placement. The introduction of split case small AC units has made it possible to provide efficient cooling solutions in spaces where ductwork is impractical or not desired, such as older buildings or rooms with limited installation options. Additionally, these AC units offer zoning capabilities, allowing for individual temperature control in different areas or rooms, maximizing comfort and energy efficiency. With their quiet operation, sleek design, and the ability to provide both cooling and heating functions, split case small AC units have become a popular choice for those seeking personalized comfort and efficient climate control.

Background

A split case small air conditioner, also known as a split system or ductless mini-split, is a compact and versatile cooling system designed for residential or small commercial spaces. Unlike traditional central air conditioning systems that rely on a network of ducts to distribute cool air, split case AC units consist of two main components: an outdoor condenser unit and an indoor evaporator unit. These components are connected by refrigerant lines and electrical wiring, allowing for efficient cooling without the need for extensive ductwork. Split case small AC units offer several advantages, including flexibility in installation, zoning capabilities, energy efficiency, and individual temperature control for different areas or rooms. They are often preferred in situations where ductwork is impractical or not desired, such as in older buildings or spaces with limited room for installation. Additionally, split case small AC units are known for their quiet operation, sleek design, and ability to provide both cooling and heating functions.

Objective

The objective of a split case small air conditioner is to provide efficient and effective cooling (and heating) solutions for residential or small commercial spaces. These compact AC units are designed to deliver optimal comfort by regulating the temperature and humidity levels within a specific area or room. The main objectives of a split case small AC include:

Major Parts of split air conditioning systems

Compressor (Outdoor)



Figure: 01

The major function of the compressor is to compress the refrigerant gas and then transfer it into liquid form.

Condenser (Outdoor)



Figure: 02

The main function of the condenser component is to cool down the air by exchanging heat with the environment. A large condenser bearing some heavy-duty ACs can compete with a refrigerator or a freezer.

Evaporator Coil (Indoor)

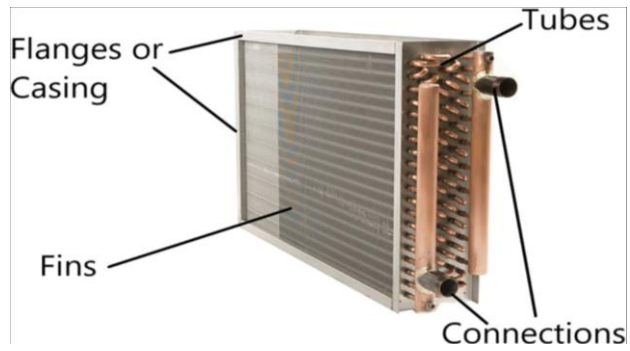


Figure: 03

The evaporator coil is another very important component of the air conditioning system. It cools down the air by absorbing heat from the environment and releasing it into a refrigerant.

Expansion Valve (Indoor)



Figure: 04

An expansion valve is a pressure controlling device that expands the refrigerant flow in order to maintain the correct pressure drop.

Capacitor (Indoor)



Figure: 05

A capacitor is used for stabilizing the system during starting of an air conditioning unit. It is also used for operating circuits and switching power.

Air Blower (Indoor)



Figure: 07

The air blower is a type of fan that helps distribute the cool air into the room. The blower is the part of the AC that makes the whole system work.

Refrigerant (System)

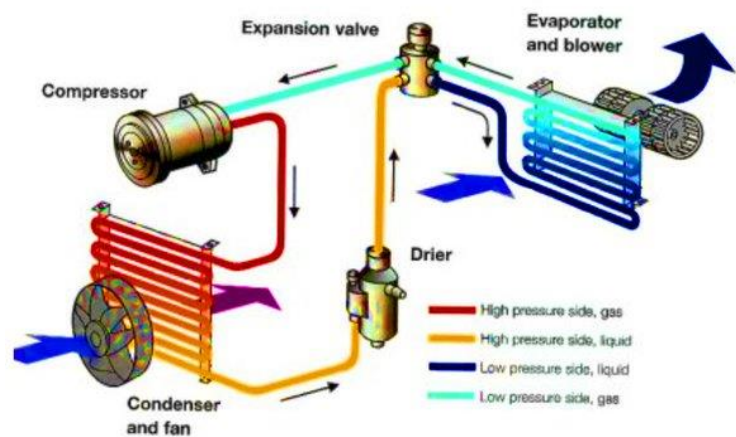


Figure: 08

The refrigerant acts as a medium that absorbs and transfers heat from one place to another. This process is called heat transfer, and it helps to cool down your room when you are having a hot day.

The compressor pumps the refrigerant into the condenser to cool down the air and then move the air out of the room at a temperature lower than before.

It is imperative to decide on R410A or R32 when you are going for a new air conditioner.

Air Filter (Indoor)



Figure: 09

An air filter is designed to allow air to flow through while blocking dust, dirt, and other solid particles. The filter is found in both the indoor parts of the AC. It needs to be cleaned every month or quarterly at the least which can be done by yourself.

Drain Hose (Indoor/Outdoor)

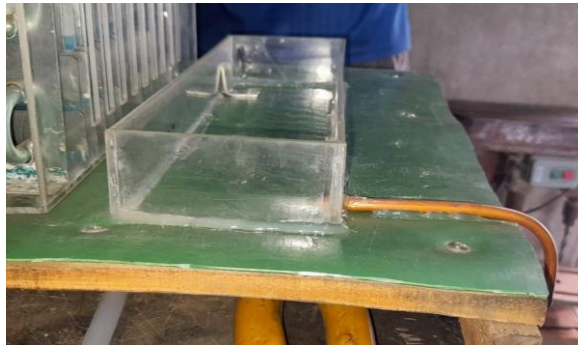


Figure: 10

The drain hose is used to drain water from the condenser. Some AC comes with a built-in pump that moves water out of the system for you, but you still need a hose for when it overflows.

Motor Fan (Outdoor)



Figure: 11

An AC fan is used to move hot air from the condenser to the environment. It serves as a vent for hot air that has been cooled by the indoor condenser.

Thermostat (Indoor)

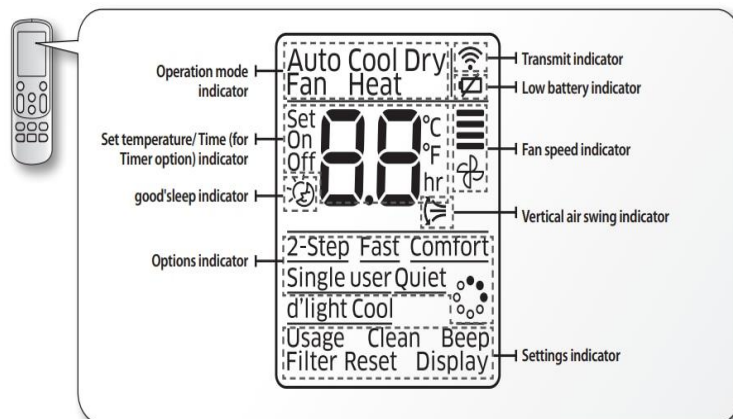


Figure: 12

A thermostat is used to regulate room temperature according to your preference. You can use the thermostat to set up cooling at a certain temperature and change it when you want to.

How a Split Air Conditioner Works in Brief

Below is the process of how the split-type AC works in general.

It involves a lot more technical aspects than what we listed here but we try to keep it simple for everyone to understand the concept.

The evaporator coil will absorb heat in the room and release it to the refrigerant

The refrigerant will move into the compressor

The compressor will compress the refrigerant even further until it forms a liquid

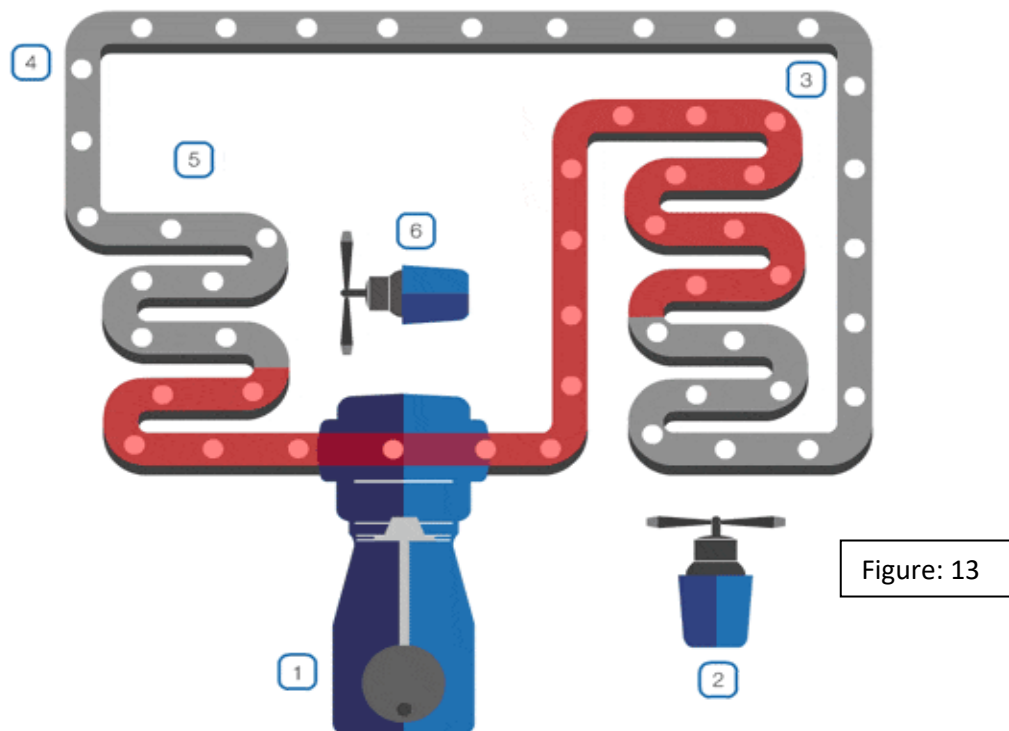
The liquid will be sent to the condenser coil where it will exchange heat with the environment and form a gas again with the motor fan to dissipate the heat

The hot liquid refrigerant will travel to the expansion valve. Depressors the refrigerant and cool it down

Low-pressure cold liquid will be flowing into the evaporator coil and will distribute out through the help of the air blower

The process will repeat and circulate until you turn them off

This gif here can illustrate the whole process visually.



Legend:

1. Compressor
2. Outdoor Motor Fan
3. Condenser Coil
4. Piping
5. Evaporator Coil
6. Indoor Air Blower

Advantages of the split air conditioner system

The split air conditioning system offers several advantages, making it a popular choice for both residential and commercial applications. Here are some key advantages of the split air conditioner system:

Efficient Cooling:

Split air conditioners are designed to provide effective cooling performance. The system consists of two units: an indoor unit and an outdoor unit. The indoor unit, typically mounted on the wall or ceiling, blows cool air into the room, while the outdoor unit houses the compressor and condenser. This separation of components allows for more efficient cooling as the heat generated by the compressor is expelled outside.

Flexibility and Zoning:

Split AC systems offer flexibility in terms of installation and zoning. With a split system, you can have multiple indoor units connected to a single outdoor unit. This enables you to create different cooling zones within your home or building, allowing for personalized temperature control in each area. Zoning helps optimize energy consumption by cooling only the necessary spaces, reducing overall energy costs.

Quiet Operation:

Split air conditioners are known for their quiet operation. The compressor and condenser, which generate most of the noise, are placed outside the building or in a separate mechanical room. As a result, the indoor unit operates quietly, creating a comfortable and peaceful environment.

Enhanced Aesthetic Appeal:

The indoor unit of a split air conditioner is sleek and compact, often mounted on the wall or ceiling. This design allows for easy integration into various interior spaces without occupying valuable floor space. Additionally, many models come with stylish and modern designs, adding to the overall aesthetic appeal of the room.

Improved Air Quality:

Split AC systems typically include advanced filtration systems that help improve indoor air quality. These filters can capture dust, pollen, allergens, and other airborne particles, providing cleaner and healthier air to breathe. Some models also come with additional features like dehumidification and air purification, further enhancing the air quality.

Energy Efficiency:

Split air conditioners are generally energy-efficient compared to traditional window units. They often come with advanced features like programmable timers, energy-saving modes, and variable-speed compressors, allowing for better control over energy consumption. With proper installation and regular maintenance, split AC systems can help reduce energy bills while providing reliable cooling.

Easy Installation and Maintenance:

Installing a split air conditioner is relatively straightforward, requiring minimal construction work. The indoor and outdoor units are connected by refrigerant lines and electrical wiring, eliminating the need for extensive ductwork. Additionally, split AC systems are typically designed for easy maintenance, with accessible filters and components that can be easily cleaned or replaced.

It is important to note that while split air conditioning systems offer numerous advantages, selecting the right system size, proper installation, and regular maintenance are crucial to ensure optimal performance and longevity.

Scope

The scope of split case small air conditioners is broad and encompasses a wide range of applications and environments. These AC units are versatile and suitable for various residential, commercial, and institutional settings. In residential applications, split case small AC units are commonly used in apartments, condos, single-family homes, and small living spaces. They offer efficient cooling solutions while minimizing the need for extensive ductwork. In commercial settings, split case small AC units are often found in small offices, retail stores, restaurants, and hotels, providing localized cooling for specific areas or rooms. These AC units are also utilized in institutional settings such as schools, hospitals, and clinics, where precise temperature control is essential for the comfort and well-being of occupants. The scope of split case small AC extends to spaces that require individual temperature control, flexibility in installation, and energy efficiency. With advancements in technology and design, these AC units continue to evolve and find applications in new and diverse settings, catering to the specific cooling needs of various environments.

Chapter: 2

Market Analysis

The market for split case small air conditioners in Bangladesh is witnessing significant growth and development. Bangladesh's climate, characterized by hot and humid summers, creates a strong demand for efficient cooling solutions, making split case small AC units highly sought after in both residential and commercial sectors.

In the residential segment, the increasing urbanization and rising middle-class population have led to a surge in demand for compact cooling systems suitable for smaller living spaces such as apartments and flats. Split case small AC units offer the advantage of easy installation without the need for extensive ductwork, making them a popular choice among homeowners. Additionally, the ability to provide individual temperature control and energy-efficient operation aligns well with the preferences and requirements of consumers in Bangladesh.

In the commercial sector, split case small AC units are widely used in various settings such as offices, shops, restaurants, and hotels. These establishments often require localized cooling for specific areas or rooms, and split case AC units provide an effective solution. The flexibility in installation, quiet operation, and zoning capabilities of these units make them ideal for commercial spaces where precise temperature control and comfort are crucial for customers and employees.

The market analysis indicates that both local and international manufacturers are actively participating in the split case small AC market in Bangladesh. Local brands, as well as renowned global brands, offer a wide range of models and options to cater to the diverse needs and budgets of consumers. Furthermore, the availability of energy-efficient models aligns with the growing focus on sustainability and energy conservation in the country.

Overall,

the market analysis suggests a positive outlook for the split case small AC market in Bangladesh, with continued growth expected in the coming years. Manufacturers and suppliers are likely to focus on introducing innovative and energy-efficient models to meet the evolving needs of consumers and to capitalize on the growing market potential.

Current Trends in Air Conditioning

Current trends in air conditioning reflect a growing emphasis on energy efficiency, sustainability, smart technology integration, and improved user experience. Some notable trends include:

Energy Efficiency:

There is an increasing demand for energy-efficient air conditioning systems as consumers prioritize reducing energy consumption and environmental impact. This trend has led to the development of advanced technologies such as variable refrigerant flow (VRF) systems, inverter compressors, and high-efficiency heat exchangers.

Sustainability:

The air conditioning industry is aligning with sustainability goals by introducing environmentally friendly refrigerants with low global warming potential (GWP), such as R-32 and R-290. Additionally, manufacturers are implementing eco-design principles to develop products with reduced carbon footprints throughout their lifecycle.

Smart Air Conditioning:

Integration of smart technology is transforming the air conditioning sector. Smart AC systems offer remote control and monitoring capabilities through mobile apps, allowing users to adjust settings, schedule operations, and receive energy consumption insights. Integration with home automation platforms and voice assistants further enhances convenience and energy management.

Air Quality Enhancement:

The COVID-19 pandemic has highlighted the importance of indoor air quality. Air conditioning systems are incorporating advanced filtration technologies, such as high-efficiency particulate air (HEPA) filters and ultraviolet germicidal irradiation (UVGI), to remove airborne contaminants and improve indoor air quality.

Multi-zone and Ductless Systems:

Multi-zone air conditioning systems allow for customized temperature control in different areas or rooms, offering enhanced comfort and energy efficiency. Ductless mini-split systems, such as split case small AC units, are gaining popularity due to their flexibility, ease of installation, and individualized temperature control.

Hybrid and Renewable Cooling:

Hybrid air conditioning systems, combining traditional cooling methods with renewable energy sources like solar power or geothermal energy, are gaining traction. These systems aim to reduce reliance on fossil fuels and minimize operating costs while maintaining efficient cooling performance.

Human-centric Design:

Manufacturers are increasingly focusing on user experience and comfort. Air conditioning systems are designed to provide precise temperature and humidity control, low noise levels, improved airflow distribution, and features like sleep mode and occupancy sensors for enhanced user comfort.

These current trends in air conditioning reflect the industry's response to evolving consumer preferences, environmental concerns, and technological advancements. The aim is to provide efficient, sustainable, and user-friendly cooling solutions while prioritizing indoor air quality and energy conservation.

Market Demand for Small AC Units

The market demand for small AC units in Bangladesh is significant and continues to grow steadily. Several factors contribute to this demand:

Climate:

Bangladesh experiences hot and humid weather conditions, especially during the summer months. The high temperatures and humidity create a strong need for cooling solutions, driving the demand for small AC units.

Rapid Urbanization:

Bangladesh has been experiencing rapid urbanization, leading to an increase in residential and commercial construction. As more apartments, flats, and small commercial spaces are built, there is a corresponding demand for compact cooling systems like small AC units that can efficiently cool these spaces without requiring extensive installation.

Population Growth and Rising Middle Class:

Bangladesh has a large and growing population, with a rising middle class that has higher disposable incomes. As living standards improve, more households are able to afford and invest in small AC units for their homes, leading to increased market demand.

Changing Lifestyles and Consumer Preferences:

With changing lifestyles, there is an increasing demand for comfort and convenience. Small AC units provide localized cooling, allowing users to cool specific areas or rooms as needed, which aligns with the preference for personalized temperature control.

Energy Efficiency and Cost Savings:

Energy efficiency has become a significant factor influencing consumer choices. Small AC units are often designed with energy-saving features, such as inverter technology and high-efficiency compressors, which appeal to consumers looking to reduce energy consumption and lower electricity bills.

Product Innovation and Availability:

Both local and international manufacturers offer a wide range of small AC units in the Bangladeshi market, providing consumers with a variety of options to choose from. Continuous product innovation, improved features, and competitive pricing contribute to the market demand.

Competitor Analysis

When conducting a competitor analysis to develop a small AC unit, it is essential to assess the strengths and weaknesses of existing competitors in the market. Here are some key aspects to consider:

Established Brands:

Identify the leading brands in the small AC market. Evaluate their market share, brand reputation, and customer loyalty. Understand what makes them successful, such as their product features, pricing strategy, distribution channels, and marketing efforts.

Product Features and Technology:

Analyze the features and technology offered by competitors' small AC units. Look for unique selling points, such as energy efficiency, smart capabilities, advanced filtration systems, noise reduction, and user-friendly controls. Assess their overall product quality, reliability, and durability.

Pricing Strategy:

Examine the pricing strategy of competitors. Determine whether they position their products as premium, mid-range, or budget options. Evaluate how pricing aligns with the target market and the perceived value of the product.

Distribution Channels:

Evaluate competitors' distribution channels, including partnerships with retailers, e-commerce platforms, and direct sales. Assess the availability and reach of their products, both in urban and rural areas.

Customer Reviews and Feedback:

Study customer reviews and feedback on competitors' small AC units. Look for common complaints or issues that customers face with existing products. Identify areas where competitors may be falling short or where customer needs are not adequately addressed.

After-Sales Service and Support:

Assess the after-sales service and support offered by competitors. Consider factors such as warranty terms, availability of service centers, customer service responsiveness, and ease of obtaining spare parts.

Market Trends and Gaps:

Identify emerging market trends and gaps that competitors may not be fully addressing. For example, consider trends such as eco-friendly refrigerants, improved air filtration systems, smart home integration, or noise reduction features. Find opportunities to differentiate your small AC unit by addressing these gaps.

Research and Development:

Explore the competitors' investments in research and development (R&D). Assess whether they are consistently introducing new features, technologies, or innovations in their products. This will help you understand the level of innovation required to stay competitive in the market.

By conducting a thorough competitor analysis, you can gain insights into the market landscape, identify opportunities for differentiation, and develop a small AC unit that meets customer needs and surpasses the competition.

Target Market Identification

To identify the target market for small AC units, it is important to consider several factors that influence the demand and preferences of potential customers. Here are some key aspects to consider when identifying the target market:

Residential Segment:

Small AC units are often popular among residential customers, especially in urban areas where apartments, flats, and small homes are prevalent. Targeting homeowners and renters in these settings can be a viable strategy. Consider factors such as household size, income levels, and lifestyle preferences to refine the target market within the residential segment.

Commercial Segment:

Small AC units also find applications in various commercial settings. Identify businesses and establishments that require localized cooling solutions, such as small offices, retail stores, restaurants, cafes, and small-scale service providers. Tailor the features and benefits of the small AC units to meet the specific needs of these businesses.

Demographic Considerations:

Consider demographic factors such as age, income level, and lifestyle preferences. Young professionals, small families, and individuals living in urban areas may have a higher demand for small AC units due to their compact size, energy efficiency, and flexibility.

Geographic Location:

Geographical location and climate play a significant role in determining the target market. Identify regions or cities with high temperatures and humid climates, as they are likely to have a greater demand for small AC units. Coastal areas or regions with extreme weather conditions can also be potential target markets.

Energy Efficiency Conscious Customers:

Target customers who prioritize energy efficiency and sustainability. Position your small AC units as environmentally friendly and highlight their energy-saving features. This can appeal to customers who are conscious of their ecological footprint and seek energy-efficient solutions.

Price Sensitivity:

Assess the price sensitivity of the target market. Small AC units can cater to customers who are looking for affordable cooling solutions or seeking cost-effective alternatives to central air conditioning systems. Pricing your products competitively and offering value for money can attract price-conscious customers.

Technologically Savvy Customers: Consider customers who are tech-savvy and value smart home integration and advanced features. Incorporate smart technology, Wi-Fi connectivity, and smartphone controls to appeal to this segment.

Customer Surveys and Market Research:

Conduct surveys and market research to gather insights directly from potential customers. This can help identify specific pain points, preferences, and unmet needs within the target market.

By considering these factors and conducting thorough market research, you can identify and define your target market for small AC units. This understanding will help tailor your marketing efforts, product features, pricing, and distribution strategies to effectively reach and serve your target customers.

Chapter: 3

Design and Development

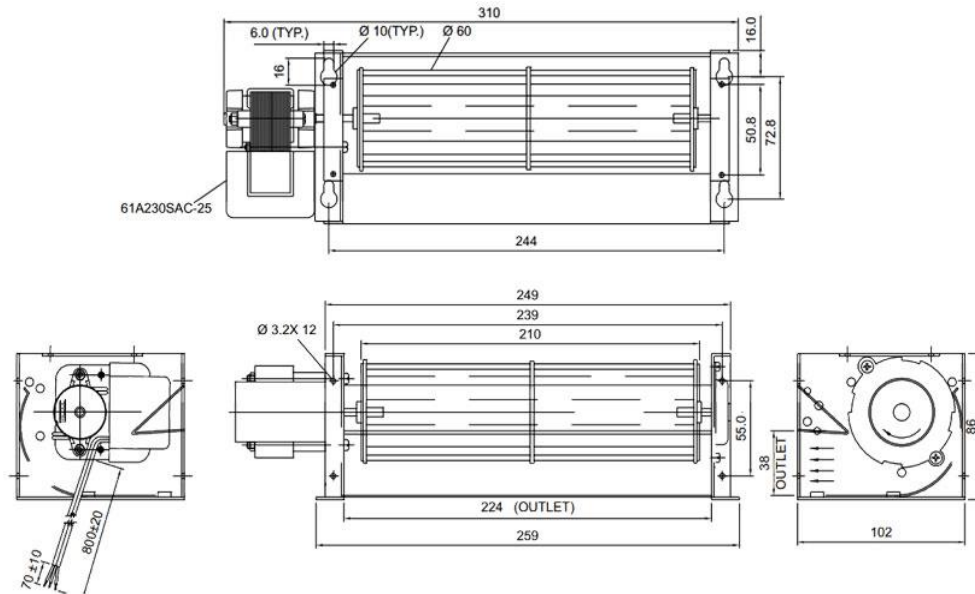


Figure: 14, Design of Indoor

Mini Split AC Unit Components

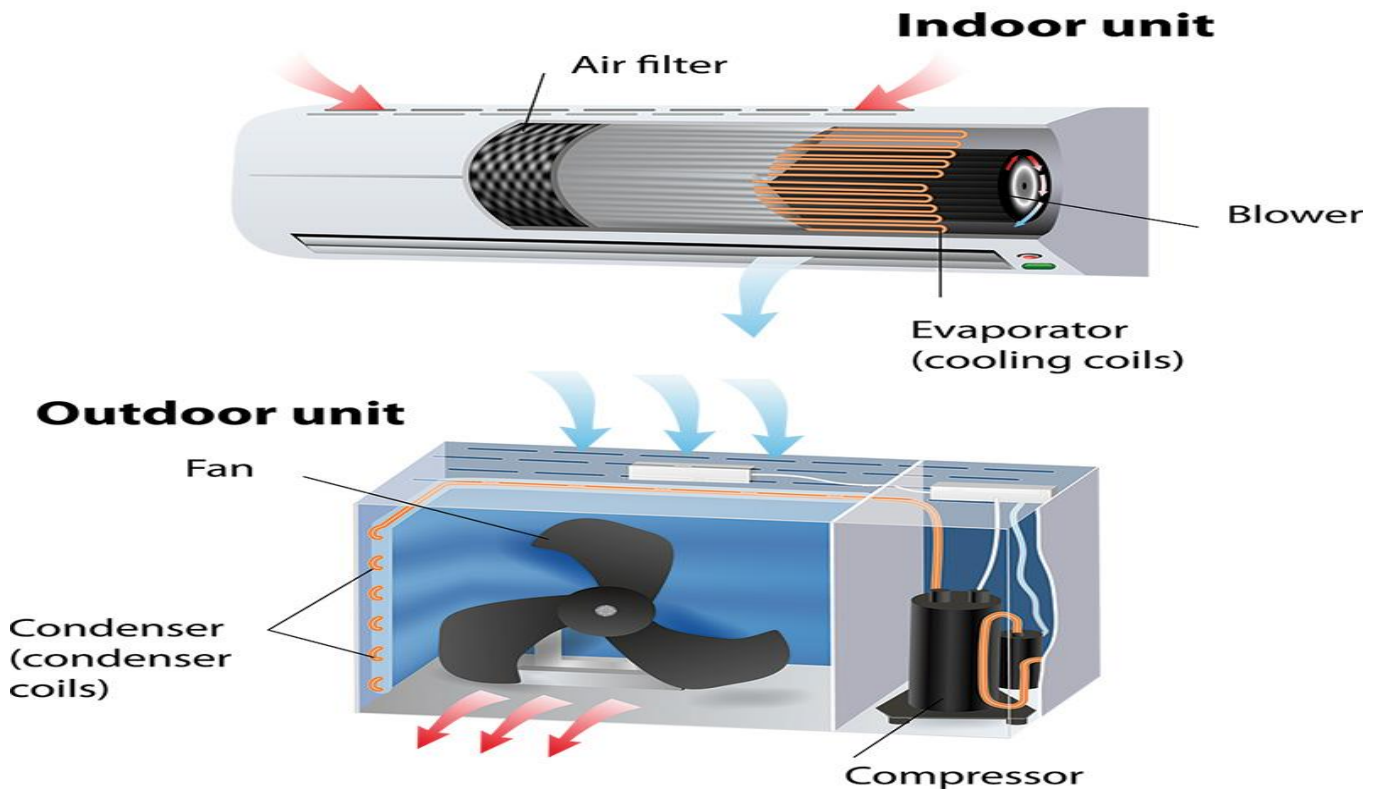


Figure: 14, Design of Out Door

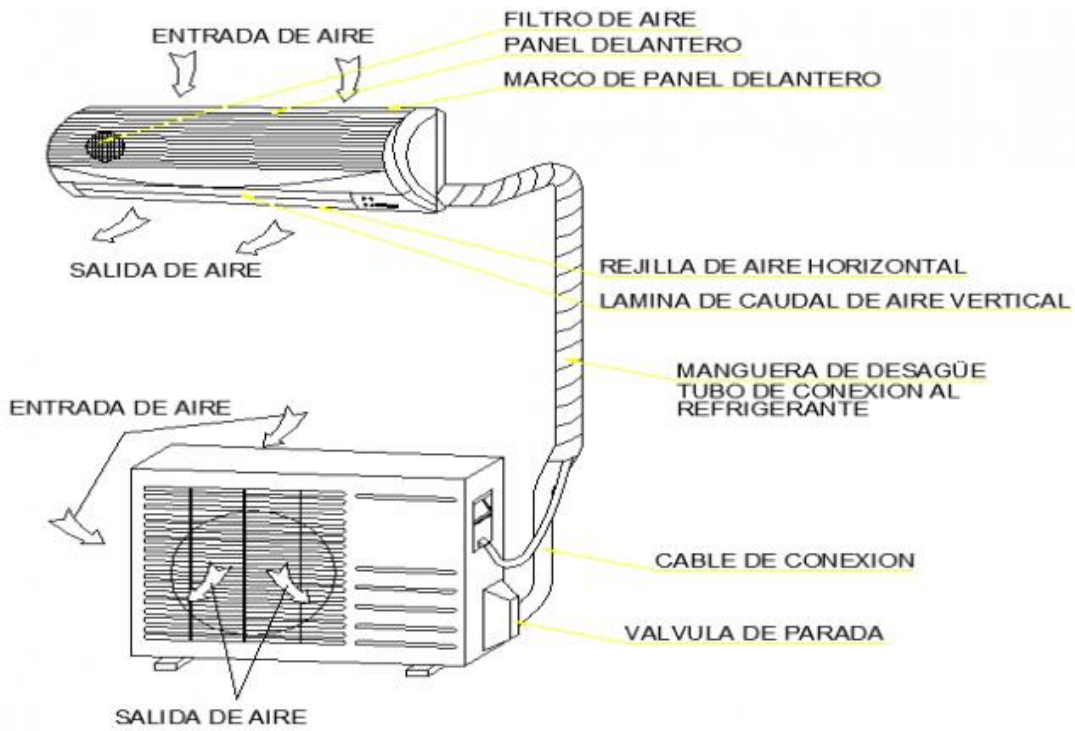


Figure: 15, Complete System Diagram

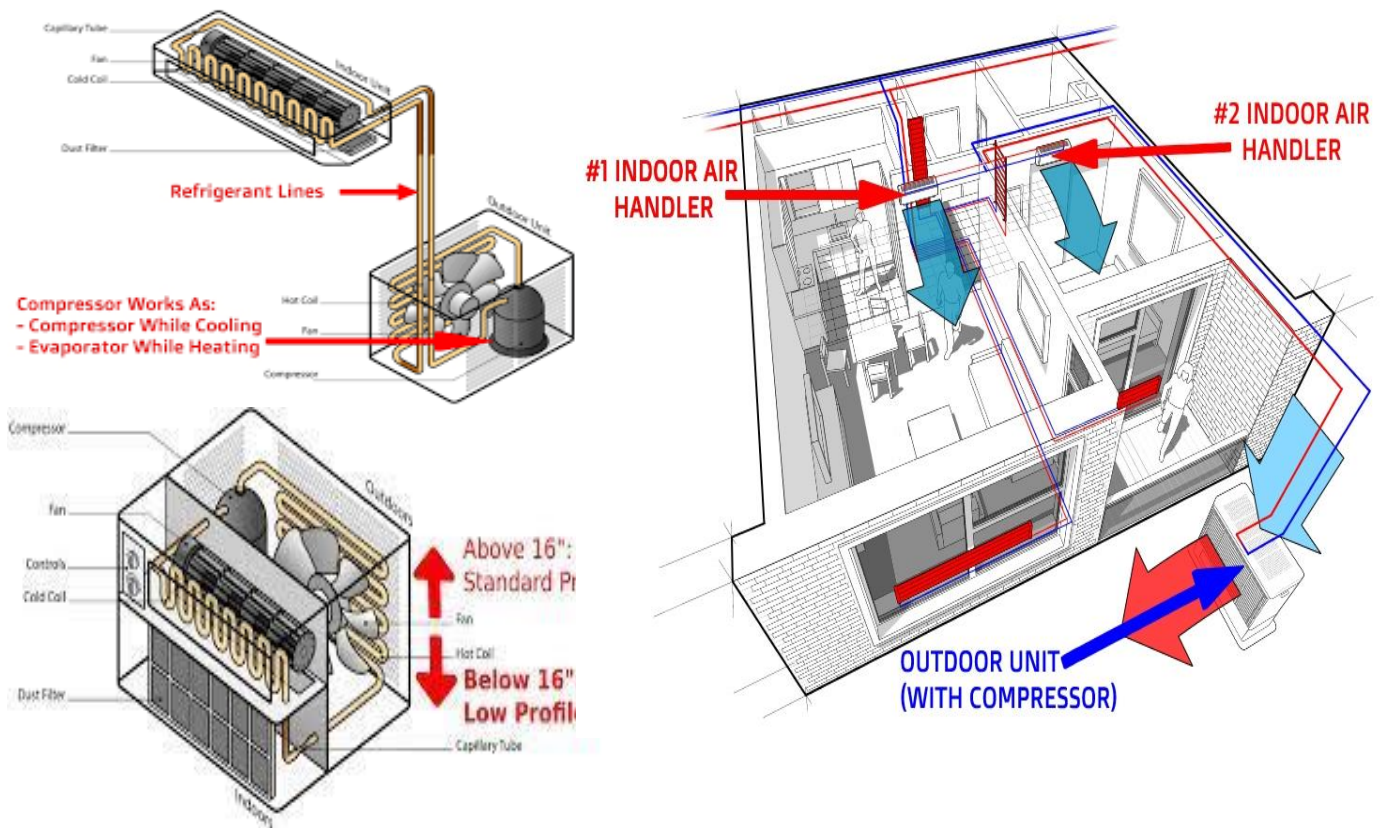


Figure: 16, Complete System Diagram

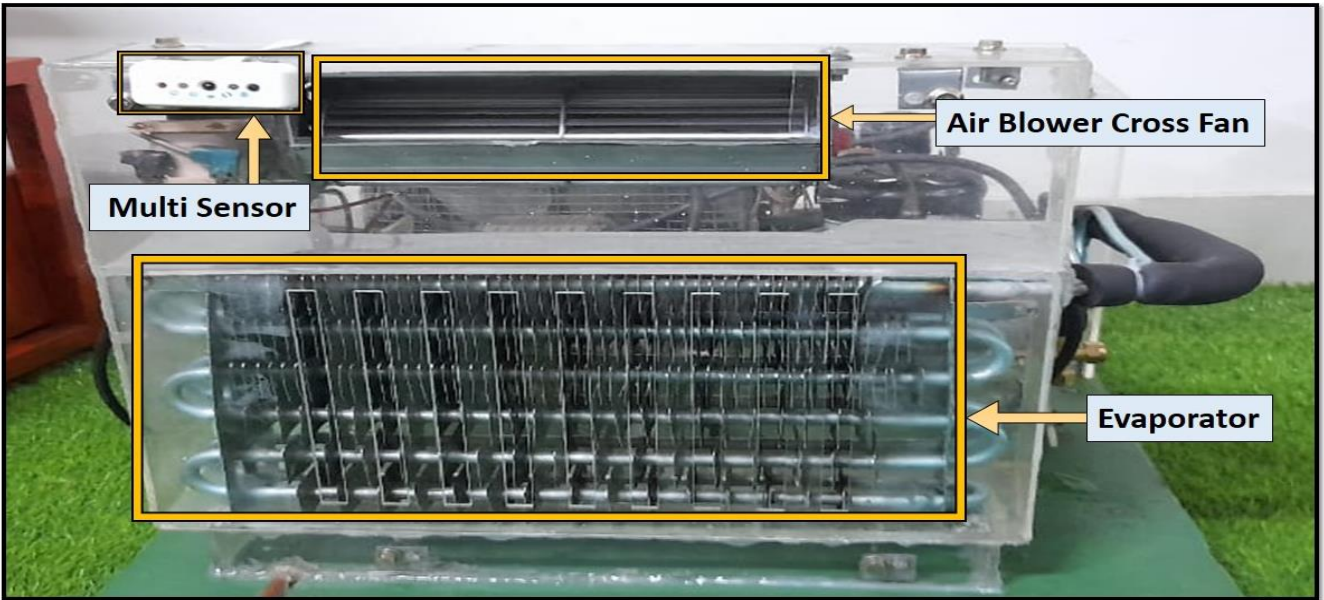


Figure: 17, Project Picture Indoor and Outdoor

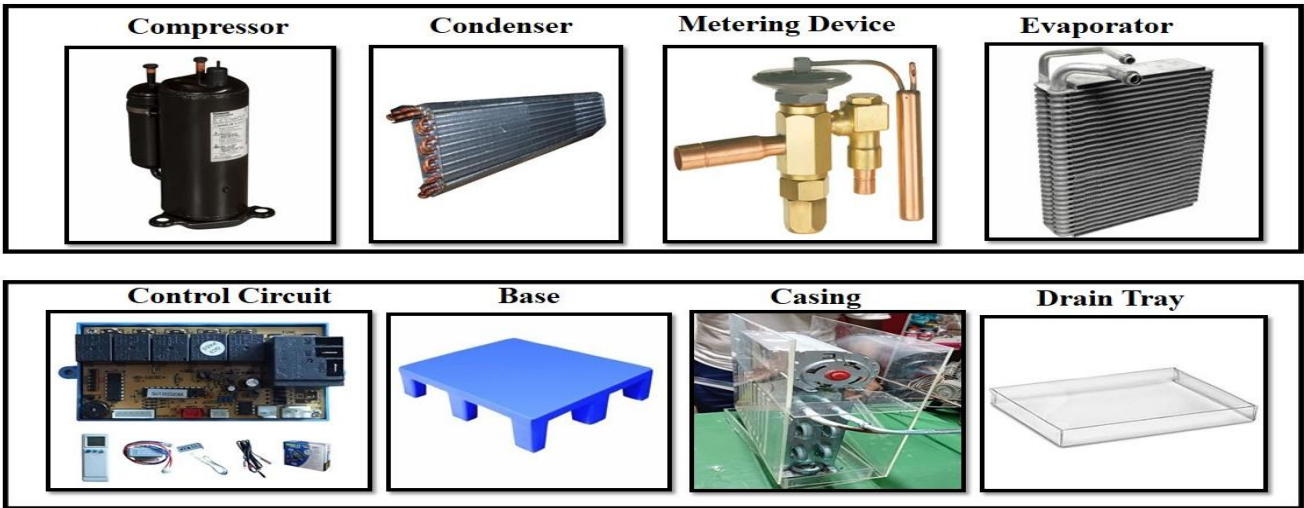


Figure: 18, Component Display

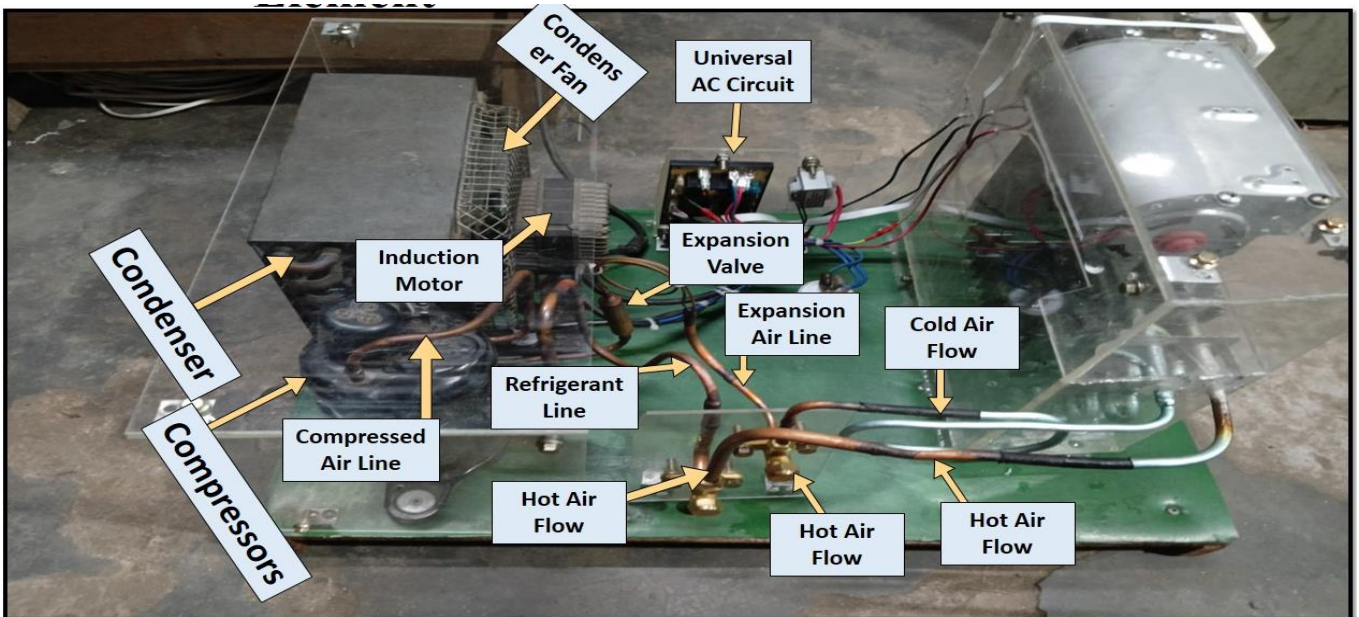
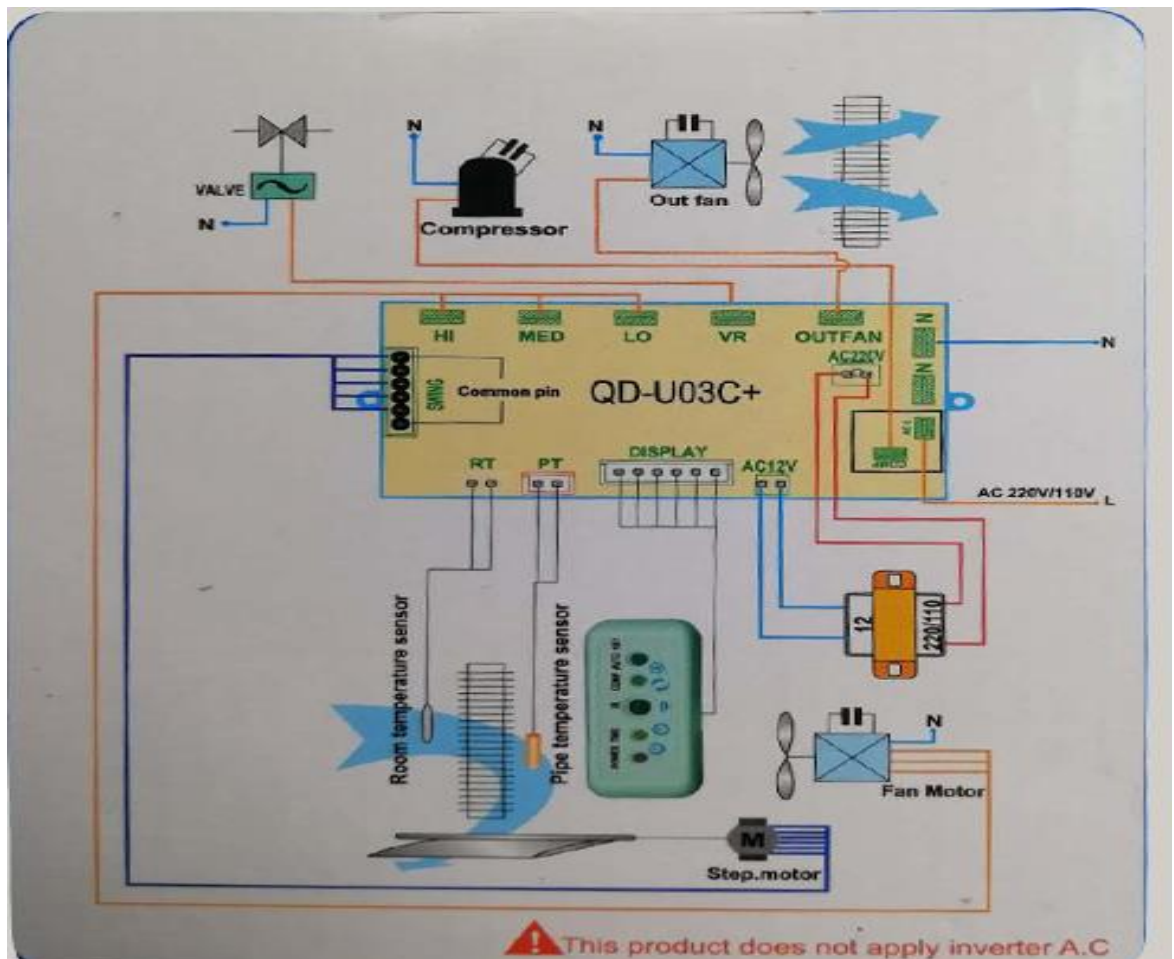
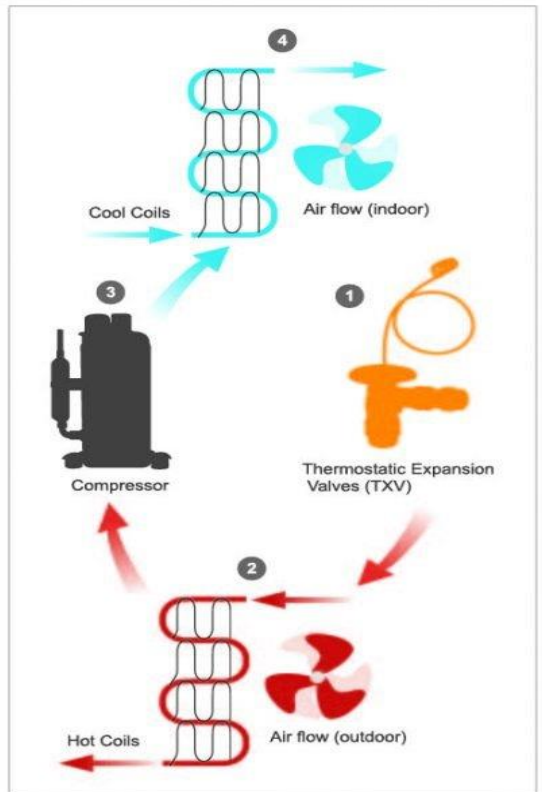
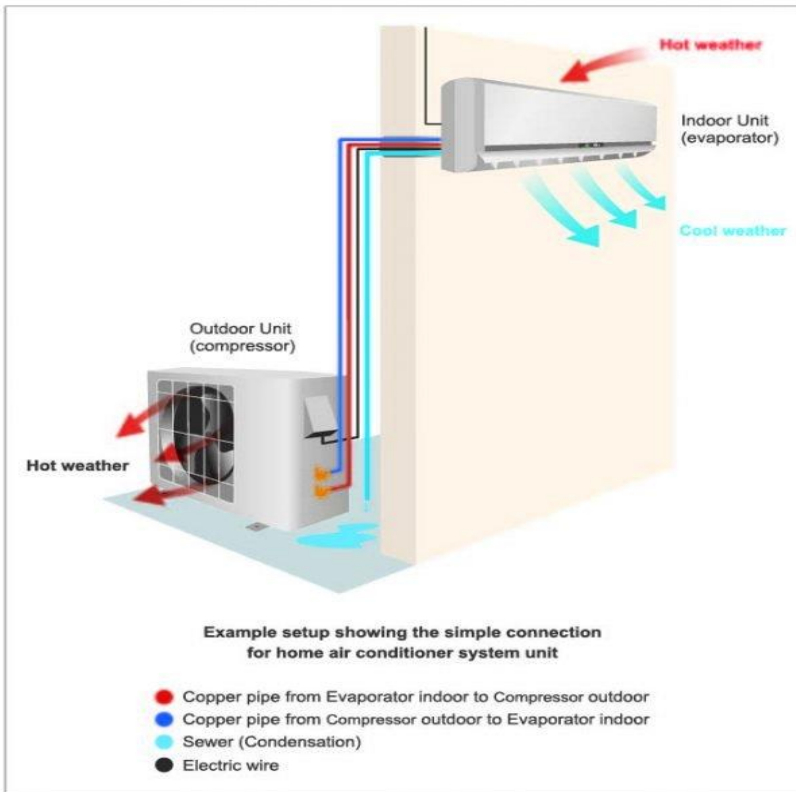


Figure: 19, All Parts Name Indication

Split Air Conditioner System



Installation Manual of Room Air Conditioner

Preparation

Necessary Tools for Installation

- Driver
- Nipper
- Hacksaw
- Hole core drill
- Spanner(17,19 and 26mm)
- Gas leakage detector or soap-and-water solution
- Torque wrench (17mm,22mm,26mm)
- Pipe cutter
- Flaring tool
- Knife
- Measuring tape
- Reamer

Power Source

- Before inserting power plug into receptacle, check the voltage without fail. The power source is the same as the corresponding name plate.
- Install an exclusive branch circuit of the power.
- A receptacle shall be set up in a distance where the power cable can be reached. Do not extend the cable by cutting it.

Selection of Installation Place

Indoor Unit

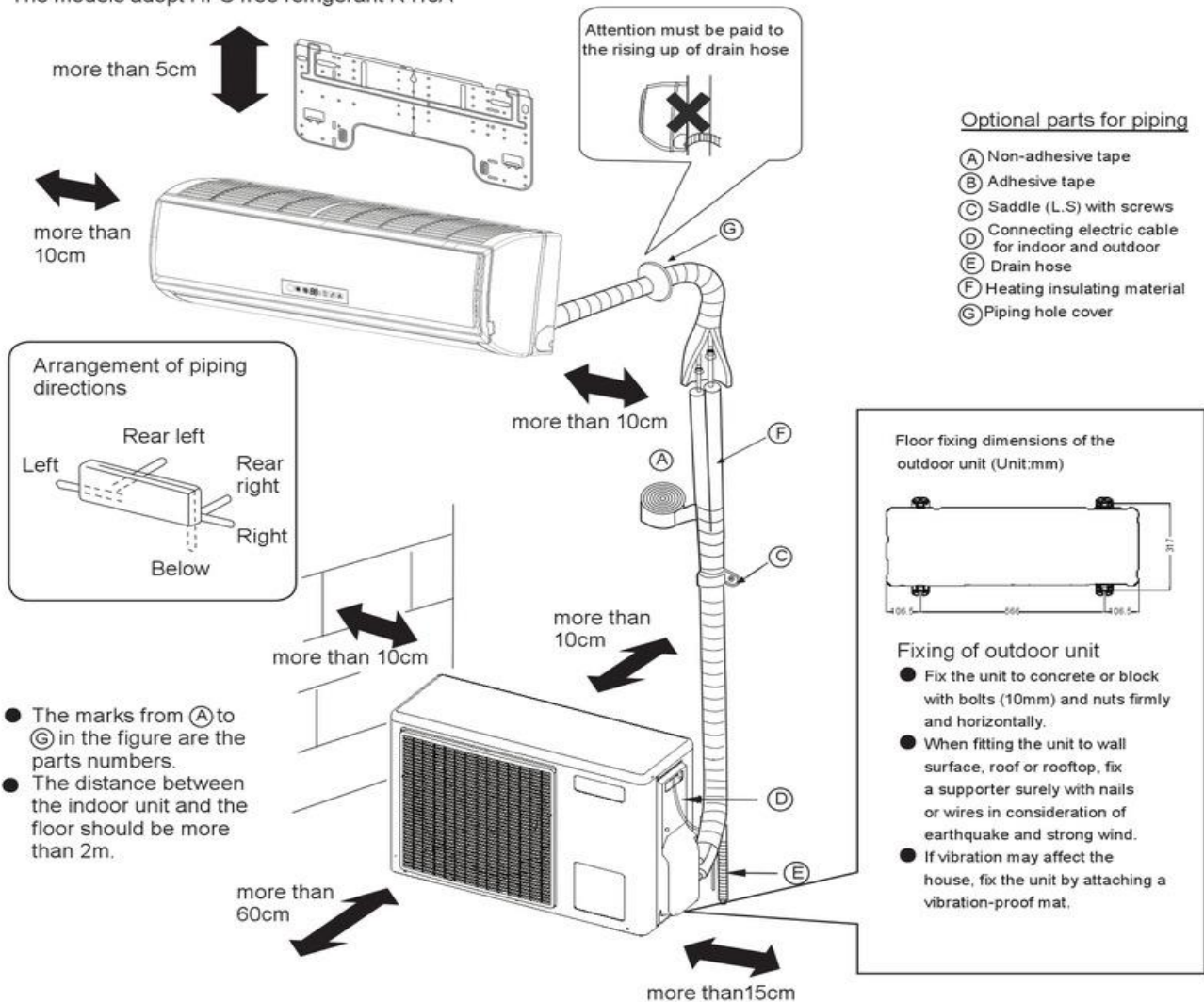
- Place, robust not causing vibration, where the body can be supported sufficiently.
- Place, not affected by heat or steam generated in the vicinity, where inlet and outlet of unit are not disturbed.
- Place, possible to drain easily, where piping can be connected with the outdoor unit.
- Place, where cold air can be spread in a room entirely.
- Place, nearby a power receptacle, with enough space around. (Refer to drawings).
- Place where the distance of more than 1m from televisions, radios, wireless apparatus and fluorescent lamps can be left.
- In the case of fixing the remote controller on a wall, place where the indoor unit can receive signals when the fluorescent lamps in the room are lightened.

Outdoor Unit

- Place, which is less affected by rain or direct sunlight and is sufficiently ventilated.
- Place, possible to bear the unit, where vibration and noise are not increased.
- Place, where discharged wind and noise do not cause a nuisance to the neighbors.
- Place, where a distance marked ↔ is available as illustrated in the above figure.

Drawing for the installation of indoor and outdoor units

The models adopt HFC free refrigerant R410A



Please be subject to the actual product purchased, the above picture is just for your reference.

Read this manual before installation

Explain sufficiently the operating means to the user according to this manual.

NO.0010519573

System Requirements

To develop a small split-type air conditioning (AC) system, you will need to consider several system requirements. These requirements are typically based on the cooling capacity, energy efficiency, and installation considerations. Here are some key system requirements to consider:

Cooling Capacity: Determine the cooling capacity required for the intended space. This is typically measured in British Thermal Units (BTUs) or tons of refrigeration (TR). Consider factors such as the room size, insulation, number of occupants, and heat-generating equipment in the space.

Energy Efficiency:

Aim for an energy-efficient system to reduce electricity consumption and operational costs. Look for AC units with high Energy Efficiency Ratio (EER) or Seasonal Energy Efficiency Ratio (SEER) ratings. Energy Star certified models are often a good choice as they meet specific energy efficiency standards.

Power Supply:

Ensure that the electrical power supply available in the installation area is suitable for the AC system. Check the voltage, phase (single-phase or three-phase), and frequency requirements of the AC unit. Properly sized electrical wiring and circuit breakers are necessary to handle the AC's power requirements.

Indoor and Outdoor Units:

Split-type AC systems consist of an indoor unit (evaporator) and an outdoor unit (condenser). Determine the space available for installation of both units. Consider factors such as wall or ceiling mounting, space clearance for airflow, and the distance between the indoor and outdoor units. Adequate drainage facilities may also be required for condensate removal.

Refrigerant Type:

Choose a refrigerant that is environmentally friendly and compliant with relevant regulations. R-410A, for example, is commonly used in modern AC systems due to its lower impact on ozone depletion. Ensure that the selected refrigerant is compatible with the AC unit and readily available.

Controls and Features:

Consider the control options and features desired for the AC system. This may include a programmable thermostat, remote control, timer, sleep mode, fan speed control, and air purifying functionalities. Select features that align with the intended usage and provide convenience to users.

Installation and Maintenance:

Ensure that the AC system can be easily installed, serviced, and maintained. Consider factors such as accessibility to the indoor and outdoor units, availability of replacement parts, and the need for professional installation or specialized tools.

Noise Level:

Evaluate the noise level produced by the AC system, especially for small spaces or areas where low noise is required. Look for units with low decibel (dB) ratings or additional noise reduction features.

It is important to note that specific requirements may vary based on local regulations, climate conditions, and individual project needs. Consulting with HVAC professionals or manufacturers can provide more accurate and detailed guidance for your specific development requirements.

Component Selection and Sourcing

When developing a small split-type AC system in Bangladesh, it's important to consider component selection and sourcing options. Here are some ideas for component selection and sourcing in Bangladesh:

Compressor:

The compressor is a critical component of the AC system. Look for reputable compressor manufacturers or suppliers in Bangladesh. Some well-known compressor brands available in the country include Panasonic, LG, Hitachi, and Daikin. Ensure that the compressor selected matches the cooling capacity and specifications of your AC system.

Condenser and Evaporator Coils: Seek local manufacturers or suppliers of condenser and evaporator coils in Bangladesh. These coils are responsible for heat transfer and should be made of high-quality materials for efficient cooling. Ensure that the coils are compatible with the refrigerant and capacity of your AC system.

Refrigerant: Choose an environmentally friendly refrigerant that complies with local regulations and has good availability in Bangladesh. R-410A is commonly used in modern AC systems due to its low impact on ozone depletion. Verify the availability of the selected refrigerant and ensure that it can be sourced easily.

Electrical Components: Source electrical components such as capacitors, relays, contactors, and control boards from local electronic component suppliers. Ensure that these components meet safety standards and are compatible with the power supply requirements of your AC system.

Fans and Blowers: Look for local suppliers of fans and blowers used in the indoor and outdoor units. These components play a crucial role in airflow and cooling efficiency. Ensure that the fans and blowers selected provide sufficient air movement and are compatible with the system's specifications.

Controls and Sensors:

Source control components such as thermostats, remote controls, and sensors from local suppliers or manufacturers. Ensure that these components have the required features and functionalities for your AC system, such as temperature control, timer functions, and mode selection.

Copper Tubing and Insulation:

Copper tubing is used for refrigerant flow between the indoor and outdoor units, while insulation prevents heat gain or loss. Look for local suppliers of high-quality copper tubing and insulation materials to ensure efficient and reliable performance.

Installation Accessories: Source installation accessories like mounting brackets, drain pipes, and refrigerant line insulation from local HVAC suppliers or wholesalers. These accessories are necessary for proper installation and maintenance of the AC system.

Chapter: 4,

Key Components and Technologies

Compressor Selection:

When selecting a compressor for a 0.25-ton split-type AC system, it's important to consider factors such as cooling capacity, energy efficiency, reliability, and availability. Here are some guidelines for compressor selection:

Cooling Capacity:

To calculate the cooling capacity of a 0.25-ton split air conditioning (AC) unit,

we need to convert tons to British Thermal Units (BTUs) and then determine the appropriate cooling capacity.

1 ton of cooling capacity is equal to 12,000 BTUs.

Therefore,

A 0.25-ton AC unit would be:

$$0.25 \text{ ton} \times 12,000 \text{ BTU/ton} = 3,000 \text{ BTU}$$

So,

0.25-ton split AC has a cooling capacity of 3,000 BTUs.

Keep in mind that this is a relatively small capacity and would be suitable for cooling small rooms or spaces, such as a small bedroom or office.

Efficiency:

Opt for a compressor with high energy efficiency to reduce electricity consumption and operational costs. Look for compressors with a high Energy Efficiency Ratio (EER) or Seasonal Energy Efficiency Ratio (SEER) rating. Higher-rated compressors are generally more efficient and can save energy over the long term.

Type of Compressor:

There are different types of compressors used in AC systems, such as reciprocating, rotary, and scroll compressors. For a 0.25-ton split-type AC, a rotary or scroll compressor is commonly used due to their compact size and efficiency. These types of compressors are known for their smooth and quiet operation.

Reliability and Durability:

Select a compressor from a reputable manufacturer known for producing reliable and durable products. Consider factors such as the brand's reputation, customer reviews, and warranty coverage. Reliability is crucial to ensure the long-term performance and lifespan of the AC system.

Availability and Service Support:

Ensure that the selected compressor is readily available in the market, preferably from local suppliers or distributors. Availability of spare parts and service support is essential for maintenance and repairs. Choosing a compressor with good market presence can help facilitate easy sourcing and maintenance.

Compliance with Regulations:

Verify that the selected compressor complies with local regulations and standards. Check for certifications or approvals from relevant authorities, such as energy efficiency certifications or safety standards.

Cost Considerations:

While it's important to prioritize quality and performance, consider the cost of the compressor within your budget. Compare prices from different suppliers or manufacturers while keeping in mind the reputation and reliability of the compressor.

When selecting a compressor, it's advisable to consult with HVAC professionals or manufacturers who can provide specific recommendations based on your project requirements and the availability of compressors in your region.

Chapter: 5

Manufacturing and Assembly

Manufacturing and Assembly Steps for Small Split Type AC

Manufacturing and assembling a small split type air conditioning (AC) system involves a series of steps to ensure the production of a reliable and efficient cooling unit. The following steps outline a general manufacturing and assembly process for a small split type AC:

Component Procurement:

Identify and procure all the necessary components required for the split type AC system, including the indoor unit, outdoor unit, refrigerant lines, electrical components, compressor, condenser, evaporator, fan, filters, and other relevant parts.

Indoor Unit Assembly:

- a. **Housing Assembly:** Assemble the indoor unit's housing, which includes the front panel, chassis, and other structural components.
- b. **Evaporator Installation:** Install the evaporator coil, blower fan, and other internal components within the indoor unit housing, following the manufacturer's instructions.
- c. **Electrical Wiring:** Connect the electrical wiring within the indoor unit, ensuring proper insulation and secure connections.
- d. **Control Board Installation**
- b. **Install the control board and interface panel,** ensuring proper positioning and connection with the electrical components.
- e. **Final Testing:** Conduct initial testing to ensure the functionality and proper operation of the assembled indoor unit.

Outdoor Unit Assembly:

- a. Housing Assembly: Assemble the outdoor unit's housing, including the chassis, fan, condenser coil, compressor, and other structural components.
- b. Refrigerant Line Connections: Connect the refrigerant lines to the condenser coil, ensuring proper sealing and insulation.
- c. Electrical Wiring: Connect the electrical wiring within the outdoor unit, following the manufacturer's wiring diagram and safety guidelines.
- d. Control Components: Install the control components, such as relays, capacitors, and overload protection devices, as per the manufacturer's specifications.
- e. Final Testing: Conduct initial testing to ensure the functionality and proper operation of the assembled outdoor unit.

Flow Chart of Operation Control

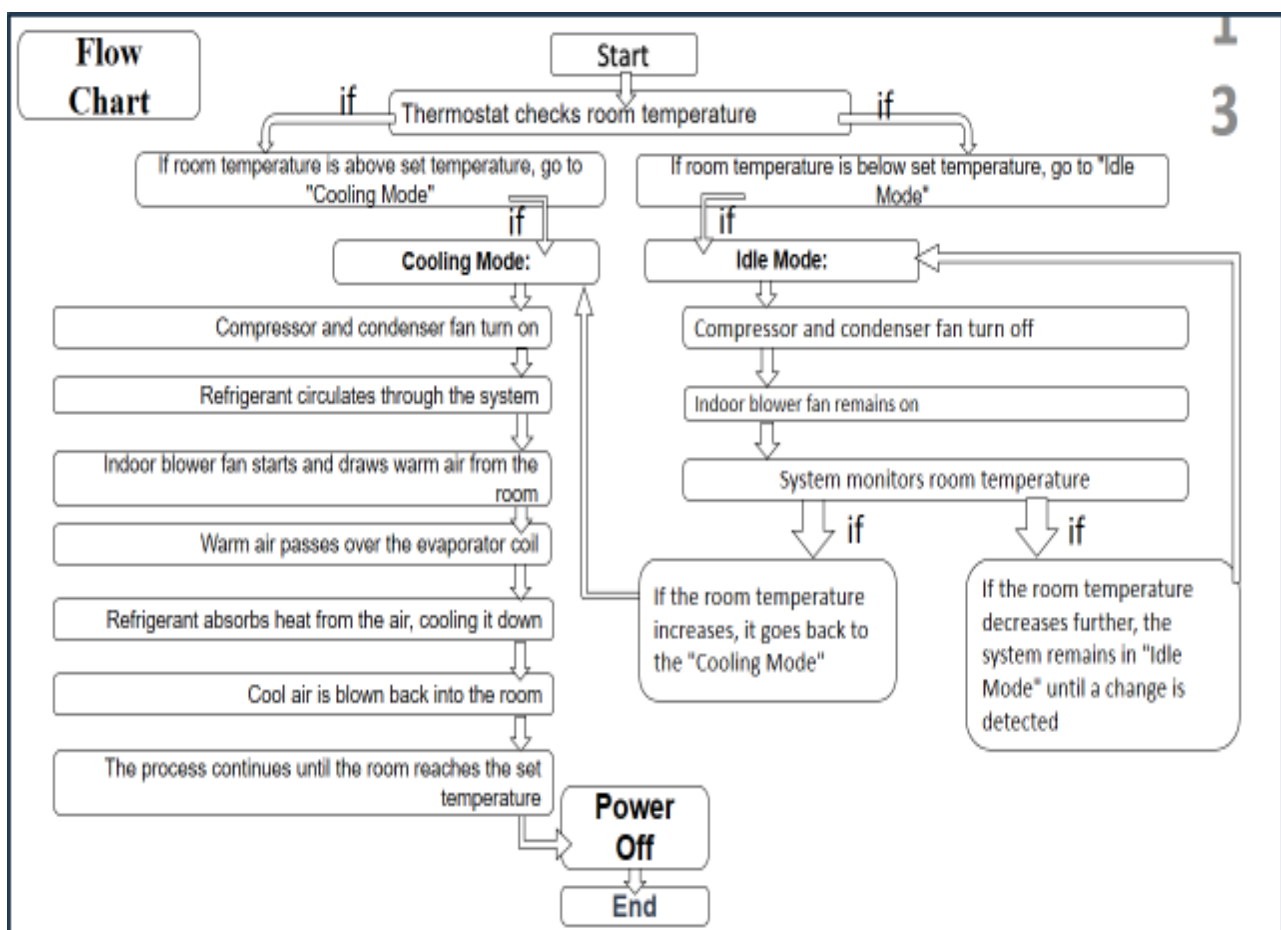


Figure: 21 Flow Chart of Operation Control

Refrigerant Charging:

- a. **Refrigerant Selection:** Determine the appropriate refrigerant type and quantity based on the manufacturer's recommendations and regulatory guidelines.
- b. **Refrigerant Charging:** Charge the system with the designated refrigerant using the appropriate charging equipment and procedures. Ensure accurate measurement and adherence to safety precautions.

Quality Control and Testing:

- a. **Functional Testing:** Conduct comprehensive testing of the assembled split type AC unit to verify its cooling capacity, airflow, temperature control, and overall performance.
- b. **Quality Checks:** Perform quality control checks to ensure that all components are properly installed, connections are secure, and there are no manufacturing defects.
- c. **Safety Testing:** Verify that the unit meets safety standards and regulatory requirements, including electrical safety, insulation, and grounding.
- d. **Efficiency Evaluation:** Assess the energy efficiency of the system by measuring power consumption and cooling performance in different operating conditions.

Packaging and Shipping:

- a. **Packaging:** Properly package the assembled split type AC units, ensuring protection from damage during transportation and storage. Include necessary accessories, manuals, and documentation.
- b. **Shipping:** Arrange for shipping or distribution of the packaged units to the intended destinations, following logistics and delivery protocols.

Installation Process

Installing a small split type air conditioning (AC) system involves several steps to ensure proper placement, connection, and functionality. The following installation process provides a general guideline for installing a small split type AC:

1. Select the Installation Location:

- Determine the best location for the indoor unit (evaporator) and outdoor unit (condenser). Consider factors such as room size, accessibility, structural support, and airflow requirements.
- Ensure that the installation location complies with local building codes, safety regulations, and manufacturer's guidelines.

Indoor Unit Installation:

Mounting: Install the indoor unit on a wall using brackets or mounting plate, ensuring it is secure, level, and properly aligned. Follow the manufacturer's instructions for precise positioning.

Airflow Clearance: Maintain sufficient clearance around the indoor unit for proper airflow, typically at least 6-8 inches from any obstructions such as furniture or curtains.

Refrigerant Lines:

Connect the refrigerant lines from the indoor unit to the outdoor unit. Use appropriate fittings, valves, and insulation to prevent refrigerant leaks and ensure efficient operation.

Drainage:

Connect the condensate drainage pipe from the indoor unit to a suitable drainage system, ensuring proper slope and insulation to prevent water accumulation or leakage.

Outdoor Unit Installation:

Mounting:

Install the outdoor unit on a stable and level surface, such as a concrete pad or mounting brackets. Ensure proper clearance from walls or other objects as specified by the manufacturer.

Airflow Clearance:

Allow adequate clearance around the outdoor unit for airflow and maintenance access. Ensure there are no obstructions, vegetation, or debris that could hinder performance.

Electrical Connection: Connect the outdoor unit's electrical wiring to the power supply following local electrical codes and safety standards. Ensure proper grounding.

Refrigerant Lines: Connect the refrigerant lines from the outdoor unit to the indoor unit, ensuring proper sealing and insulation. Avoid kinks or sharp bends in the lines.

Condenser Discharge: Install a condenser discharge line to redirect condenser heat or condensate away from the outdoor unit, following manufacturer's instructions and local regulations.

Electrical and Control Wiring:

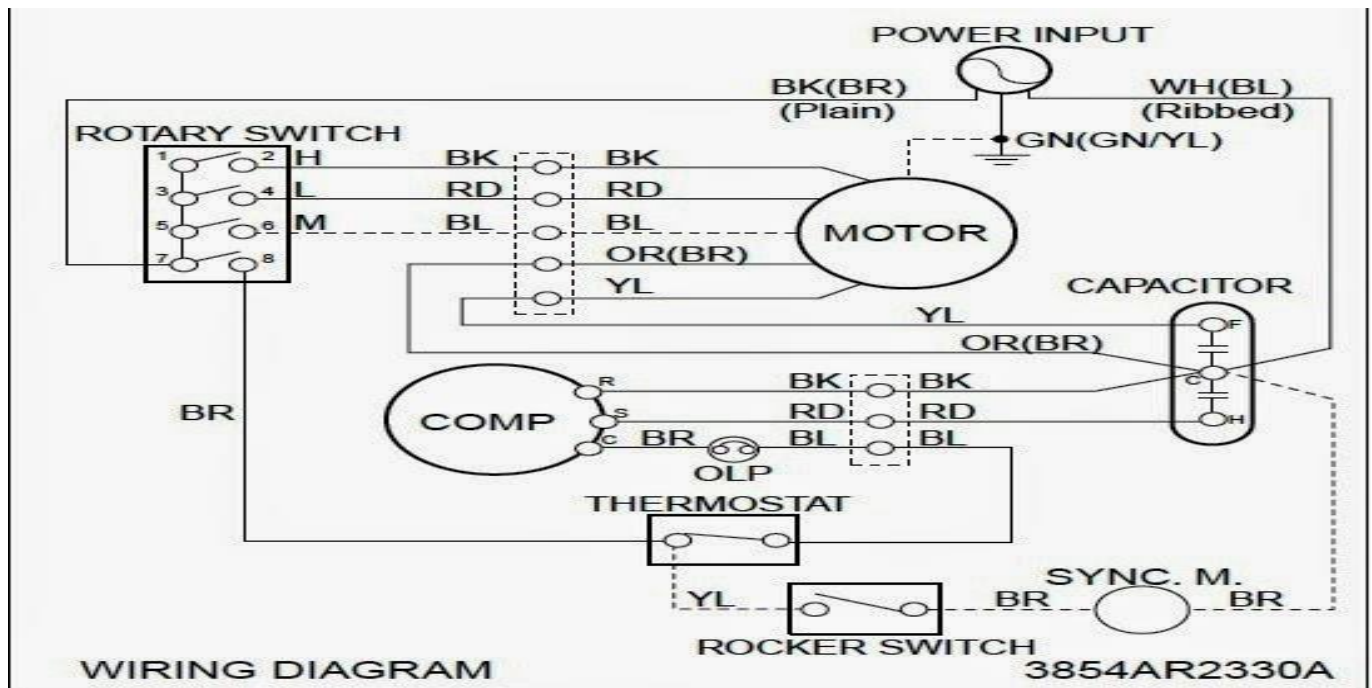


Figure: 22. Power Wiring

Control Wiring:

Connect the control wiring, such as thermostat or remote control wires, following the manufacturer's guidelines and wiring diagram. Ensure proper insulation and labeling.

Final Checks and Testing:

- Double-check all connections, fastenings, and wiring for tightness and security.
- Test the system by turning on the power supply and operating the AC unit.
- Check for any abnormal sounds, vibrations, or visible issues.
- Test the cooling function, fan operation, and thermostat settings to ensure proper operation.
- Verify that the unit is cooling and maintaining the desired temperature.
- Measure and adjust airflow, if necessary, to ensure optimal air distribution.

User Instructions and Handover:

- Provide the user with operating instructions, including how to control the AC unit, adjust settings, and maintain the system.
- Explain the importance of regular maintenance and cleaning to optimize performance and prolong the system's lifespan.
- Answer any questions the user may have and address any concerns.

Quality Control Measures

Difference between R134a and R600a Compressor

While purchasing a refrigerator for your home, you might be wondering the difference between R134a and R600a compressors, what changes do they bring to your refrigerator, and which one is better.

Given its low Global Warming Potential, R600A has grown in favor throughout the years (GWP). As a result, it is now the ideal refrigerant for light commercial and home refrigeration devices such as freezers, freestanding display units, refrigerators, and beverage dispensers. The refrigerant is non-toxic, has no ODP, and performs exceptionally well in thermodynamics.

We will break down the differences between R134a and R600a compressors to make them more comprehensible for you.

The Vapor Compression Refrigeration cycle is used in a domestic refrigerator. The evaporator, compressor, condenser, and expansion device are all critical components of the cycles.

The compressor's job is to raise the pressure of the working fluid (also known as refrigerant) from the evaporator to the condenser.

Isobutene (R600a) is the HC most commonly found in residential fridges and freezers, even though a variety of HCs have refrigerant uses.

- These are the common differences between R134a and R600a compressors:

Because of its high water solubility, R134a (tetrafluoroethene) is less suitable for refrigeration systems. Even if there is just a little quantity of water present, the lubricating oil will create acid, carbon dioxide, or carbon monoxide, which will cause metal corrosion, therefore R134a requires more drying and cleaning. R600a (isobutene) is water-soluble and compatible with most metals, including carbon steel, stainless steel, copper, and aluminum.

- R134a is non-flammable in the air and has very low toxicity. A1 is the highest level of safety. It's a completely risk-free refrigerant.

R600a has a mild irritant and anesthetic effect. It is a combustible gas. When blended with air, it can generate a combination. In the presence of heat and open flames, it may burn. When it comes into touch with oxidants, it reacts strongly. Its vapor is heavier than air and may travel a long distance at a low level before igniting when it comes into contact with a fire source. R134a has a little amount of greenhouse gas impact. R600a has no influence on the environment.

The evaporation pressure, condensing pressure, and exhaust temperature of R600a are lower than those of R-134a. Because of the lower liquid density of R600a refrigerant, the charge volume is 45 percent that of R-134a, the refrigeration performance is good, and the refrigeration capacity is 55 percent that of R-134a;

R134a refrigerant and mineral lubricating oil are incompatible, and the cleanliness standards of the manufacturing process and refrigeration system components are excessively stringent. Refrigerator energy usage has also grown with the use of R134a refrigerants. At the same time, the refrigerant has a greenhouse effect. The impact isn't the best alternate refrigerant route.

The benefits of common hydrocarbon refrigerants like isobutane (R600a) just barely outweigh the drawbacks of R134a refrigerants. R600a's outstanding thermophysical qualities define the refrigerant's use. Its energy efficiency is better than that of CFCs and HCFCs. The compressor's efficiency (COP value) and the refrigerator's refrigeration efficiency (power consumption index) are both higher than R134a. Germany was the first country to effectively employ hydrocarbons as refrigerants in refrigerators due to the benefits of energy savings and reduced emissions. R600a refrigerant has become widely employed in China's refrigeration sector as the technique and technology have matured.

Is R134a Better or R600a?

Because of its environmentally favorable qualities, R600A has become the refrigerant of choice. Let's have a look at some of the uses for this refrigerant.

The refrigerant is utilized in the production of geothermal energy.

R600A is used in beverage dispensers and is suited for industrial refrigeration.

It's a component of dehumidifiers.

Plug-ins and vending machines may both use R600A.

They're also utilized in aerosol sprays and as feedstock in the petrochemical sector.

What is the safety of R600A refrigerant? To begin, you must handle the refrigerant with extreme caution, and you must carry and pack it according to the manufacturer's instructions.

Furthermore, because R600A is combustible, it should be kept away from open flames. When working with R600A, you must also wear a mask since breathing the gas is dangerous.

R134A is not water-soluble. Under the action of lubricating oil, water will create acid, carbon monoxide, or carbon dioxide, resulting in metal corrosion. The system must be cleaned and dried before the refrigerant can be used.

Most metals, including aluminum, stainless steel, copper, and carbon steel, are compatible with R600A, which is mildly soluble in water.

R134A is in the safety category A1 since it is non-flammable and has low toxicity. R600A is combustible and might induce discomfort and poor anesthesia.

It creates a BaoZa mixture when combined with air, and it can react strongly when contacted with oxidants.

The refrigerant R134A has a greenhouse impact, whereas R600A has none. The condensing pressure, evaporation pressure, and exhaust temperature are all lower in R600A.

When developing a small split type air conditioning (AC) system, it is crucial to prioritize safety throughout the design, manufacturing, and installation processes. Here are some key safety considerations to keep in mind:

Electrical Safety:

Adhere to electrical codes and regulations while designing and manufacturing the AC system to ensure safe operation and prevent electrical hazards.

Use appropriate electrical components, such as wiring, connectors, and circuit breakers that meet safety standards and can handle the electrical load.

Provide proper insulation and grounding for all electrical connections to minimize the risk of electrical shocks or short circuits.

Conduct regular inspections and testing to ensure the electrical components and connections are secure and functioning correctly.

Refrigerant Safety:

- Follow environmental regulations and guidelines regarding the use and handling of refrigerants.
- Select refrigerants that are environmentally friendly and have low global warming potential (GWP) to minimize environmental impact.
- Ensure proper installation and sealing of refrigerant lines to prevent leaks and release of refrigerants into the atmosphere.
- Educate technicians and users about the safe handling and disposal of refrigerants to prevent personal injury and environmental contamination.

Structural Integrity:

- Design the AC system and its components to withstand normal operational stresses and environmental conditions.
- Ensure that the indoor and outdoor units are securely mounted and supported, considering factors such as weight, vibration, and wind loads.
- Perform structural calculations and testing to verify the stability and strength of mounting brackets, chassis, and other structural elements.
- regularly inspect the system for signs of damage or deterioration, particularly after severe weather events or environmental stressors.

Airflow and Ventilation:

- Consider airflow requirements during the design and installation of the AC system to ensure proper ventilation and prevent stagnant air or inadequate air exchange.
- Maintain appropriate clearance around the indoor and outdoor units to allow for proper airflow and heat dissipation.
- Avoid obstructing the intake and discharge vents of the AC units, both indoors and outdoors, to maintain efficient operation and prevent overheating.

User Safety and Instructions:

- Provide clear and comprehensive user instructions and safety guidelines with the AC system to educate users about its safe operation, maintenance, and potential risks.
- Include safety labels and warnings on the AC units and controls to alert users to potential hazards and precautions.

- Emphasize the importance of regular maintenance, such as cleaning filters and inspecting electrical connections, to ensure safe and efficient operation.
- Encourage users to seek professional assistance for installation, repairs, and maintenance to minimize the risk of accidents or improper handling.

Compliance with Standards:

- Adhere to relevant safety standards, regulations, and certifications applicable to AC systems, such as electrical safety standards, environmental regulations, and energy efficiency standards.
- Conduct thorough testing and quality control checks during the development and manufacturing processes to ensure compliance with safety standards and regulations.

Chapter: 6

Performance Evaluation

The cooling capacity testing process for a small split air conditioner (AC) typically involves the following steps:

Prepare the test environment: Set up a controlled test environment that closely resembles the conditions in which the AC unit will be installed and used. This includes ensuring proper insulation, sealing any gaps, and maintaining stable indoor and outdoor temperatures.

Measure the airflow: Use an airflow measuring device to determine the amount of air being circulated by the AC unit. This involves measuring the supply air volume and return air volume to calculate the airflow rate.

Measure the temperature differentials: Place temperature sensors at strategic locations, such as the supply air vent and return air vent, to measure the temperature differentials. This involves recording the temperature of the air entering the AC unit and the temperature of the cooled air leaving the unit.

Calculate the cooling capacity: With the airflow rate and temperature differentials recorded, you can calculate the cooling capacity of the AC unit using the following formula:

$$\text{Cooling Capacity (BTU/hr)} = \text{Airflow Rate (CFM)} \times \text{Temperature Difference (°F)} \times 1.08$$

Alternatively,

if you prefer metric units:

$$\text{Cooling Capacity (kW)} = \text{Airflow Rate (m}^3\text{/hr)} \times \text{Temperature Difference (°C)} \times 1.163$$

Repeat the test:

It is recommended to conduct multiple tests to ensure consistent results and account for any variations. This helps to verify the cooling capacity of the AC unit under different operating conditions and ensure accuracy.

Reference the manufacturer's specifications: Compare the obtained cooling capacity with the manufacturer's specifications to ensure compliance and validate the unit's performance.

Chapter: 7

Environment Consideration

Test Environment Preparation:

Set up a controlled test environment that represents the typical operating conditions for the AC system. This may include a small room or a test chamber with appropriate insulation and ventilation.

- Install temperature sensors at strategic locations within the test environment to measure the ambient temperature accurately.
- Ensure the test environment has stable electrical power and is equipped with appropriate safety measures.

Instrumentation:

- Install temperature sensors on the indoor and outdoor units to monitor the air temperature at the evaporator and condenser coils, respectively.
- Connect pressure sensors to the refrigerant lines to measure the pressure differentials across the coils.
- Use a power meter to measure the electrical power consumption of the AC system during the test.

Baseline Measurement:

- Record the initial ambient temperature, indoor temperature, and outdoor temperature.
- Set the AC system to its default or specified cooling mode, ensuring the thermostat is set to the desired temperature.
- Allow the AC system to run for a sufficient period to stabilize its operation and achieve a steady-state condition.

Cooling Capacity Calculation:

- Measure the airflow rate entering the indoor unit using an anemometer or similar instrument.
- Measure the temperature difference (delta T) between the air entering the evaporator coil and the air exiting the coil.
- Calculate the cooling capacity of the AC system using the formula: Cooling Capacity (in BTU/hr) = Airflow Rate (in CFM) x Delta T (in °F) x 1.08

Repeat Testing:

- Repeat the cooling capacity test under different operating conditions, such as varying the set temperature, fan speed, or ambient temperature.
- Perform multiple tests to ensure consistency and validate the cooling capacity across different scenarios.

Performance Evaluation:

- Compare the measured cooling capacity with the specified cooling capacity provided by the manufacturer.
- Evaluate the AC system's performance based on the cooling capacity test results and assess its compliance with design specifications and industry standards.
- Analyze any discrepancies or deviations and identify potential factors that may affect the cooling capacity, such as airflow restrictions, refrigerant charge, or system inefficiencies.

Documentation and Reporting:

- Record all the test data, including ambient temperatures, temperature differentials, airflow rates, power consumption, and calculated cooling capacities.
- Prepare a comprehensive report summarizing the cooling capacity test results, including any observations, deviations, and recommendations for improvements if necessary.

Chapter: 8, Documentation and Reporting

1: Equipment and Materials Documentation

Documenting the list of equipment and materials required for the installation

Recording specifications, model numbers, and quantities of AC units and components

Tracking the delivery and storage of equipment to ensure proper inventory management

2: Installation Procedures and Guidelines

Documenting step-by-step procedures for AC system installation

Detailing guidelines for mounting indoor and outdoor units, connecting refrigerant lines, and electrical wiring

Highlighting safety precautions and compliance with industry standards and regulations

3: Site Preparation Documentation

Documenting site preparation activities, such as electrical and structural requirements

Recording any modifications or adjustments made to accommodate the AC system

Documenting site inspection reports, including photographs or diagrams if applicable

4: Wiring and Connection Documentation

Documenting the electrical wiring and connection diagrams for the AC system

Recording the layout and routing of cables, ensuring compliance with electrical codes

Documenting the connection of control wiring and communication lines, if applicable

5: Testing and Verification Documentation

Documenting the testing procedures conducted during the installation phase

Recording the results of pressure tests, refrigerant charge verification, and leak detection

Documenting verification of electrical connections, voltage measurements, and control functionality

6: As-Built Documentation

Creating as-built drawings or documentation that reflects the actual installed configuration

Documenting any deviations or modifications made during the installation process

Recording changes in the system layout, equipment placement, or wiring connection

7: Commissioning Documentation

Documenting the commissioning activities, including functional tests and performance verification

Recording the results of commissioning tests, such as temperature differentials and airflow measurements

Documenting the adjustment of control settings and calibration procedures

8: Health and Safety Documentation

Documenting health and safety measures implemented during the installation phase

Recording safety inspections, risk assessments, and safety equipment usage

Documenting training and certification records for installation personnel

9: Handover Documentation

Preparing handover documentation to the end-user or client

Including operating instructions, maintenance requirements, and warranty information

Documenting any outstanding issues or follow-up actions required after installation

10: Documentation Review and Approval

Establishing a documentation review and approval process for accuracy and completeness

Ensuring documentation compliance with project requirements and standards

Documenting the sign-off and acceptance of the installation documentation by relevant stakeholders

By exploring the topics covered in this chapter, practitioners involved in small air conditioning projects will gain valuable insights and guidelines on how to effectively document the implementation and installation phase. Proper documentation ensures that the installation process is carried out smoothly, enhances traceability, and serves as a valuable resource for future maintenance and troubleshooting activities.

Pricing and Cost Analysis

Costing Sheet for Develop Small Split AC					
SL	Description	Utity	Qty	Unit Price (BDT)	Total (BDT)
1. Indoor Unit (Evaporator):					
1.1	Mounting brackets or mounting plate	Set	1	500	500
1.2	Electrical wiring and connectors	Lot	1	1200	1200
1.3	Refrigerant lines and insulation	Feet	10	20	200
1.4	Condensate drainage pipe and fittings	Lot	1	500	500
1.5	Thermostat or control unit (if not included with the indoor unit)	Set	1	0	0
1.6	Fasteners, screws, and other installation hardware	Lot	1	0	0
2. Outdoor Unit (Condenser):					
2.1	Split AC outdoor unit (including necessary parts and accessories)	Set	1	4500	4500
2.2	Mounting brackets or concrete pad	Lot	0	0	0
2.3	Electrical wiring and connectors	Lot	0	200	0
2.4	Refrigerant lines and insulation	Feet	10	20	200
2.5	Condenser discharge line and fittings	Lot	0	0	0
2.6	Fan motor and fan blades	Set	0	0	0
2.7	Compressor unit	Set	1	7000	7000
2.8	Fasteners, screws, and other installation hardware	Lot	0	200	0
3. Electrical Components:					
3.1	Circuit breaker or fuse box	Set	0	350	0
3.2	Power supply cables and wiring	Lot	1	250	250
3.3	Electrical connectors and terminals	Lot	0	150	0
3.4	Grounding equipment	Lot	0	250	0
3.5	Electrical switches and controls	Set	1	500	500
3.6	Junction boxes and cable trays	Lot	0	200	0
4. Refrigerant and Refrigerant Accessories:					
4.1	Environmentally friendly refrigerant (as per regulations and manufacturer's specifications)	Litre	0.5	1200	600
4.2	Refrigerant pipes and fittings	Lot	1	350	350
4.3	Refrigerant valves and controls	Set	0	500	0
4.4	Refrigerant charging equipment	Set	0	200	0
5. Miscellaneous Items:					
5.1	Insulation materials (for refrigerant lines and ducts, if applicable)	Lot	0	250	0
5.2	Air filters	Set	0	150	0
5.3	Drainage pipe connectors and accessories	Set	0	250	0
5.4	Ductwork (if applicable)	Set	0	600	0
5.5	Grilles or vents (if applicable)	Set	0	200	0
6. Labor and Installation:					
6.1	Labor cost for installation, assembly, and testing	Person	3	1200	3600
6.2	Transportation and handling costs	Pkg	2	2500	5000
6.3	Tools and equipment necessary for installation and testing	Set	1	700	700
Grand Total					25100

Chapter: 9

Challenges and Lessons Learned

Building a small AC project can come with its own set of challenges and lessons learned. Some common challenges and lessons learned during the process include

Research and Development:

Developing a small AC project requires thorough research and development to understand the market needs, technical specifications, and regulatory requirements. It is important to conduct comprehensive market research and feasibility studies to ensure the viability of the project.

Design and Engineering:

Designing a small AC unit involves overcoming space constraints while ensuring optimal cooling capacity and energy efficiency. It is crucial to strike a balance between size, performance, and cost to meet customer expectations.

Component Sourcing:

Finding reliable suppliers and sourcing high-quality components at reasonable costs can be a challenge, especially when dealing with specialized components specific to AC units. Establishing a strong supply chain and maintaining good relationships with suppliers are vital to overcome this challenge.

Manufacturing and Assembly:

Setting up an efficient manufacturing and assembly process for small AC units requires careful planning and optimization. Streamlining production, ensuring quality control, and training the workforce are crucial aspects to focus on.

Testing and Certification:

Proper testing and certification are essential to ensure the safety, performance, and compliance of the small AC units. Engaging with accredited testing laboratories and certification bodies is necessary to meet industry standards and regulatory requirements.

Cost Management:

Balancing the cost of production and the final price of the small AC units is critical to remain competitive in the market. Efficient cost management practices, such as optimizing manufacturing processes, minimizing waste, and negotiating favorable terms with suppliers, can help control costs.

Market Acceptance and Competition:

Introducing a new small AC unit into the market can be challenging due to existing competition and customer preferences. Conducting effective marketing and promotional activities, highlighting the unique features and benefits of the product, and providing excellent customer support are crucial for market acceptance.

After-Sales Service and Maintenance:

Offering reliable after-sales service, including timely maintenance, repairs, and customer support, is essential for customer satisfaction and building brand loyalty. Establishing a robust service network and training service technicians can help overcome this challenge.

Continuous Improvement:

Learning from customer feedback, market trends, and technological advancements is vital to continuously improve the small AC project. Regularly upgrading the product, incorporating new features, and staying abreast of industry developments can ensure the project's long-term success.

By being prepared for these challenges and implementing lessons learned from previous experiences, the development and implementation of a small AC project can be smoother and more successful. Flexibility, adaptability, and a focus on customer satisfaction are key factors to keep in mind throughout the project.

Project Management Lessons

When managing a project for installing small split air conditioners (ACs), here are some key project management lessons to keep in mind:

Define project objectives: Clearly define the objectives and scope of the project. Determine the specific requirements for the small split AC installation, including the number of units, locations, desired cooling capacity, and any special considerations.

Develop a project plan:

Create a detailed project plan that outlines the tasks, timelines, and dependencies. Consider factors such as procurement of equipment, site preparation, installation, testing, and commissioning.

Allocate resources:

Identify the necessary resources for the project, including skilled technicians or contractors, equipment, materials, and budget. Ensure that resources are allocated efficiently and effectively to meet project requirements.

Coordinate with stakeholders:

Engage with stakeholders such as clients, facility owners, maintenance teams, and contractors. Keep them informed about the project's progress, involve them in decision-making processes, and address any concerns or issues promptly.

Risk management:

Identify potential risks and develop strategies to mitigate them. Consider risks such as delays in equipment delivery, changes in project scope, weather conditions, and unforeseen technical challenges. Regularly monitor and evaluate risks throughout the project lifecycle.

Communication and documentation:

Establish effective communication channels among team members, stakeholders, and suppliers. Document project-related information, such as contracts, permits, equipment specifications, installation plans, and testing results. This documentation helps maintain transparency, facilitates collaboration, and provides a reference for future maintenance or upgrades.

Quality control:

Implement quality control measures to ensure that the small split AC units are installed and commissioned correctly. Conduct thorough inspections, testing, and verification of the cooling capacity and performance. Address any deficiencies promptly and ensure compliance with relevant standards and regulations.

Project monitoring and tracking:

Regularly monitor project progress against the defined schedule and milestones. Track key performance indicators, such as completion percentage, budget utilization, and adherence to quality standards. Use project management tools or software to aid in tracking and reporting.

Change management:

Be prepared to handle changes in project scope or requirements. Establish a change management process to evaluate and approve any changes. Communicate changes effectively to the project team and stakeholders, ensuring that everyone is aware of the impact on timelines, costs, and deliverables.

Project closure and handover:

Once the small split AC installation is complete, conduct a thorough project review and handover process. Document any lessons learned, finalize project documentation, and ensure that relevant training and manuals are provided to end-users or maintenance teams.

Maintenance

To ensure optimal performance and prolong the lifespan of a 0.75-ton split air conditioning (AC) system, regular maintenance is essential. Here are some maintenance tasks to consider:

Cleaning Air Filters:

Clean or replace the air filters regularly, at least once every one to three months, or as recommended by the manufacturer. Dirty filters restrict airflow and reduce cooling efficiency.

Cleaning the Indoor and Outdoor Units:

Remove dust and debris from the indoor and outdoor units using a soft brush or vacuum cleaner. Ensure that the units are free from obstructions to maintain proper airflow.

Checking and Cleaning the Condenser Coil:

Inspect the condenser coil (located in the outdoor unit) and clean it if necessary. Use a soft brush or compressed air to remove dirt or debris that may have accumulated on the coil.

Checking and Cleaning the Evaporator Coil:

Check the evaporator coil (located in the indoor unit) and clean it if needed. Use a soft brush or a commercially available coil cleaner to remove dirt or dust that may have accumulated on the coil.

Checking and Cleaning the Drainage System:

Inspect the condensate drainage system to ensure it is clear of blockages. Clean the condensate drain pan and the drainpipe to prevent water leakage or mold growth.

Verifying Refrigerant Levels:

Check the refrigerant levels periodically to ensure they are within the manufacturer's specified range. Low refrigerant levels may indicate a leak that needs to be addressed promptly by a qualified technician.

Checking Electrical Connections:

Inspect the electrical connections of the AC system to ensure they are tight and secure. Loose connections can cause performance issues or electrical hazards.

Lubricating Moving Parts (if applicable):

Some AC units may have moving parts that require lubrication. Refer to the manufacturer's guidelines to determine if lubrication is necessary and follow the recommended procedures.

Inspecting and Cleaning the Fan Blades:

Check the fan blades in the indoor and outdoor units for dirt or damage. Clean the blades if necessary, ensuring they are balanced and in good condition.

Testing and Calibrating Thermostat:

Verify the accuracy of the thermostat and ensure it is calibrated correctly. Consider replacing the batteries if the thermostat operates on battery power.

Scheduling Professional Maintenance:

Arrange for professional maintenance at least once a year or as recommended by the manufacturer. Professional technicians can perform a comprehensive inspection, cleaning, and tune-up of the AC system, identifying any potential issues and optimizing its performance.

Advantages of a Small Split AC:

Energy Efficiency:

Small split AC units are designed for smaller spaces and lower cooling demands. They tend to be more energy-efficient compared to larger AC units, resulting in energy savings and reduced utility bills.

Precise Cooling:

A small split AC provides precise cooling control for small rooms or specific areas. It allows for maintaining a comfortable temperature in confined spaces without overcooling.

Space-Saving Design:

Split AC systems consist of separate indoor and outdoor units. The compact size of the indoor unit makes it suitable for installation in limited spaces, such as small apartments, bedrooms, or offices.

Zoning Capabilities:

Split AC systems offer zoning capabilities, allowing for individual temperature control in different zones or rooms. This feature helps customize comfort levels and can lead to energy savings by cooling only the occupied areas.

Quiet Operation:

Small split AC units are known for their quiet operation. The noise-producing components, such as the compressor and condenser, are located in the outdoor unit, minimizing indoor noise levels.

Disadvantages of a Small Split AC:

Limited Cooling Capacity:

The main disadvantage of a small split AC is its limited cooling capacity. It may not be suitable for larger spaces or areas with high heat loads. In such cases, a larger capacity AC unit would be required to ensure sufficient cooling.

Cooling Range Restrictions:

Small AC units may have limitations in their cooling range. Extreme temperatures or environments with exceptionally high heat loads may strain the unit's capabilities and affect its cooling efficiency.

Installation Complexity:

Split AC systems require professional installation, which can be more complex compared to window or portable AC units. It involves mounting the indoor unit, running refrigerant lines, and connecting electrical wiring between the indoor and outdoor units.

Cost:

The cost of a small split AC can vary depending on the brand, features, and energy efficiency ratings. While small units tend to be more affordable than larger ones, the initial investment may still be higher compared to other types of AC units.

Maintenance Challenges:

Split AC systems require regular maintenance, including cleaning the filters, coils, and drainage system. Accessing and cleaning the outdoor unit may involve climbing heights or accessing tight spaces, which can pose challenges during maintenance.

It's important to consider the specific cooling requirements, space limitations, and budget constraints before choosing a small split AC. Assessing the advantages and disadvantages will help determine whether it is suitable for the intended application or if a different capacity or type of AC unit would be more appropriate.

Small AC Demand in Bangladesh

Small ACs have a significant demand in Bangladesh due to various factors. Here are some reasons for the high demand for small ACs in Bangladesh:

Population Density:

Bangladesh has a high population density, particularly in urban areas. Small ACs are preferred for smaller living spaces, apartments, or rooms where larger AC units may not be suitable or efficient.

Affordability:

Small ACs are generally more affordable compared to larger capacity units. In a country where cost plays a crucial role in purchasing decisions, small ACs offer a more accessible option for a wider range of consumers.

Power Supply Constraints:

Bangladesh often faces electricity shortages and power supply fluctuations. Small ACs consume less power, making them a more practical choice for households and businesses, especially in areas with limited access to reliable electricity.

Climate Conditions:

Bangladesh experiences hot and humid weather, particularly during the summer season. Small ACs provide localized cooling and can effectively maintain comfortable indoor temperatures in smaller spaces, such as bedrooms, offices, or small shops.

Urbanization and Commercial Spaces:

With rapid urbanization and the growth of commercial sectors, the demand for cooling solutions in small shops, cafes, offices, and other small commercial spaces has increased. Small ACs are a popular choice for such establishments due to their size, efficiency, and affordability.

Energy Efficiency:

Energy efficiency is a growing concern in Bangladesh, given the rising energy costs and environmental considerations. Small ACs tend to be more energy-efficient compared to larger units, allowing users to save on electricity bills while reducing their carbon footprint.

Improved Standard of Living:

As the standard of living improves and disposable incomes rise, the demand for appliances like small ACs increases. Consumers are looking for comfortable and convenient cooling solutions, especially in urban areas where lifestyles are evolving.

It is important for AC manufacturers and retailers to understand the specific needs and preferences of consumers in Bangladesh to cater to the demand for small ACs effectively. Factors such as affordability, energy efficiency, and suitability for smaller spaces are key considerations when developing and marketing small AC units in the country.

Appendix

The appendix section of the small AC theses book provides supplemental information and materials that support the content presented in the main chapters. It includes additional data, charts, figures, and other relevant resources that enhance the understanding and completeness of the research. Here are some potential components that could be included in the appendix:

- 1. Research Questionnaires and Surveys:** If surveys or questionnaires were conducted as part of the research, include the copies of the questionnaires or surveys in the appendix. This allows readers to see the specific questions asked and provides transparency in data collection.
- 2. Data Collection Tools and Instruments:** Provide details and specifications of the tools and instruments used for data collection, such as sensors, meters, or monitoring devices. Include photographs or diagrams to illustrate their setup and usage.
- 3. Raw Data and Analysis:** Include raw data sets and analysis results that were used to draw conclusions in the main chapters. This allows readers to access and scrutinize the data for their own analysis or to validate the research findings.
- 4. Calculation Methods and Formulas:** If specific calculations or formulas were employed in the research, include them in the appendix. This provides transparency and allows readers to understand the underlying mathematical or statistical methods used.
- 5. Supplementary Figures and Charts:** Include any additional figures, charts, or graphs that provide supplementary information to the research findings. These visuals can further illustrate trends, correlations, or comparisons related to the small AC systems studied.

- 6. Experimental Setup Details:** If laboratory experiments or field trials were conducted, provide detailed descriptions of the experimental setup, including equipment specifications, environmental conditions, and any unique procedures followed. This information helps readers replicate or understand the experimental process.
- 7. Sample Documentation Templates:** Offer sample templates of important documentation used in small AC projects, such as installation checklists, commissioning forms, maintenance logs, or change request forms. These templates can serve as a reference for practitioners or researchers in the field.
- 8. Glossary of Terms and Abbreviations:** Include a glossary that provides definitions for technical terms and abbreviations used throughout the book. This ensures clarity and ease of understanding for readers who may be less familiar with certain terminology.
- 9. References and Citations:** Provide a comprehensive list of references and citations used in the book, following the appropriate citation style guidelines (e.g., APA, MLA). This allows readers to easily access the sources and continue their own research on the topic.

The appendix section adds depth and credibility to the small AC theses book by providing supplementary materials and resources. It serves as a valuable reference for readers who wish to delve deeper into the research or explore specific aspects in more detail.

Reference:

1. IEEE Xplore, ScienceDirect
2. University Libraries: Visit the libraries of renowned universities with engineering or HVAC departments.
3. ASHRAE Journal, HVAC&R Research, and International Journal of Refrigeration for articles and studies on small AC systems and related topics.
4. ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) and REHVA (Federation of European Heating, Ventilation, and Air Conditioning Associations) for research papers, technical reports, and guidelines related to small AC systems.
5. Books and Textbooks: Refer to textbooks on HVAC systems and energy-efficient building design, as they often cover small AC systems as part of the overall HVAC system. Examples include "HVAC Systems Design Handbook" by H. P. Gauchel and "Principles of Heating, Ventilation, and Air Conditioning" by Ronald H. Howell.
6. Online Research Repositories: Explore online research repositories like arXiv.org and Research Gate, where researchers and academics share their research papers and theses in various disciplines, including HVAC and energy efficiency.